Draft plan for Chimoio's Excellence Center Hydropower Division

by

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To my family

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Finally I would like to thank all the stakeholders, students and people in general that have contributed to the project.

Declaration

I state and declare that this thesis was prepared by me and that no means or sources have been used, except those, which I cited and listed in the Bibliography section.The thesis is in compliance with the rules of good practice in scientific research of Carl von Ossietzky Universität Oldenburg. (CEARE 2011)

Oldenburg, 19 of March 2012 _____

Abstract

Mozambique has large amounts of hydro resources which could contribute strongly to increase the electrification rate and the development of the rural economies.

The resources have been known to exist in different areas of the country for a long time, but was always the responsibility of organizations, usually bringing experts from abroad, to design and implement projects in the HP field, thus nulling the possibility of local professionals to acquire experience. The lack of proper local training made this effect even more noticeable.

In a join partnership with local Institutions of Higher Education and under its Capacity Building program, GIZ AMES-M, planned to develop a training Center that would allow local instructors to prepare the future Mozambican professionals in the hydropower industry.

The present document prepares the ground for such a center to be developed. A detailed analysis of each stakeholders was done, identifying what their self-set goals are and how can they contribute to the project. A risk assessment analysis was carried, identifying the factors that could endanger the center and those that could prevent the stakeholders to achieve their objectives.

A Capabilities assessment was performed on the local institutions to understand which are the courses and knowledge related to the field of hydropower available and how could they be used in the center.

The Terms of Reference for the Chimoio's Excellence Center - Hydropower Division was written balancing the interests of the different stakeholders and aiming for the best outcome for all.

Finally a short Investment analysis was performed on the expected expenses for the initial stages of the establishment of the center.

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List of Acronyms

Governmental, Public and Related

DIPREME Direcçao Provincial dos Recursos Minerais e Energía (Provincial Directory of Energy and Mineral Resources)
DPOPH Direcção Provincial de Obras Públicas e Habitação (Provincial Directorate of Public Works and Housing)
FUNAE Fundo de Energia(Energy Fund)
ARA-Centro Administração Regional das Águas Centro (Central Region Water Administrations)
EDM Electricidade de Moçambique (Public Company of Electricity of Mozambique)
MoE Ministry of Energy
UTIP Unidade Técnica de Implementação dos Projectos Hidroeléctricos
PARPA Action Plan for the Reduction of Absolute Poverty
SAPP Southern African Power Pool

Organizations and related

GIZ Deutsche Gesellschaft fur Internationale Zusammenarbeit (German International Cooperation)
EndDev Dutch-German energy partnership Energizing Development
AMES-M Access to Modern Energy Services program in Mozambique
AKSM Associação Kuaedza Simucai Manica (Kuaedza Simucai Manica Association)
NGO Non Governmental Organization

Higher Education Institutions and related

UP Universidade Pedagógica (Pedagogic University)
UCM Universidade Católica de Moçambique (Catholic University of Mozambique)
ISPM Instituto Superior Politecnico de Manica (Higher Polytechnic Institute of Manica)
UniZambeze Universidade Zambeze (Zambeze University)
ESEG School of Higher Education for Economy and Management
PPRE Postgraduate Programme Renewable Energy

Hydropower and Related

RE Renewable Energy
HP Hydropower
HPP Hydropower Plant
MHP Micro Hydropower
SHP Small Hydropower
HCB Cahora Bassa Hydropower station
PUE Productive Use of Energy

Units

PWh Petawatt hour(s) (10^{15} Wh)
TWh Terawatt hour(s) (10^{12} Wh)
GWh Gigawatt hour(s) (10^{9} Wh)
MWh Megawatt hour(s) (10^{6} Wh)
kWh Kilowatt hour(s) (10^{3} Wh)
Wh Watt hour(s)
GW Gigawatt(s) (10^{9} W)
MW Megawatt(s) (10^{6} W)
kW Kilowatt(s) (10^{6} W)
W Watt(s)

Excellence Center and related

ECHD Excellence Center - Hydropower Division
EC Excellence Center
ExC Executive Council
SC Superior Council
EAB External Advisory Board
MOU Memorandum of Understanding
ToR Terms of Reference

1. Introduction

This chapter provides a description of Mozambique, Manica province and Chimoio city (where the Excellence Center - Hydropower Division will be implemented), as well as a description of GIZ Ames-M project. It was written in cooperation with Sandra Chavez, who was another PPRE student doing her internship in Chimoio at the same time and for the same organization.

1.1 Mozambique

1.1.1 Location

Located in the southeastern Africa, is bordered by the Indian Ocean to the east, Tanzania to the north, Malawi and Zambia to the northwest, Zimbabwe to the west and Swaziland and South Africa to the southwest. The total area of Mozambique is 799380 km^2 , from North to South to the East it has coastline with the Indian Ocean for over 2515 km .

Fig 1.1 Mozambique's location in the world
(Source: Wikipedia (#1) 2011)

Index	Value	Explanation
Population (millions)	23.4	
GDP per capita (US$)	410	
HDI	0.317	Place 184 of 187 Countries
Rural Population (millions)	14.4	
Life Expectancy (years)	49	
Literacy rate (%)	55	People of 15 years of age and above
HIV (%)	14	Total (% population between ages 15 to 49)
Poverty Index (%)	54.7	Under the national poverty line (2008)
Electrification rate (%)	16	Connected to National grid (EdM)

Table 1.1 Synthesis of the main socio-economic indicators of Mozambique.
(Source: The World Bank Group 2011)

Fig 1.2 Coasts of Mozambique
(Source: Authors photo)

1.1.2 Mozambique Political division

Mozambique is divided into ten provinces and one capital city with provincial status.

- Cabo Delgado
- Gaza
- Inhambane
- Manica
- Maputo (capital city)
- Nampula
- Niassa
- Sofala
- Tete
- Zambezia

Fig 1.3 Provinces of Mozambique
(Source: http://beaumont.tamu.edu/ClimaticData/WorldMaps/4_34.gif)

1.1.3 History

Portugal began to colonize the area that became Mozambique in the early 16th century.
In 1974, with the Frelimo independence movement, Portugal colonial rule ended after ten-years of war.
The Renamo movement, an anti-Frelimo resistance group sponsored by Rhodesia and South Africa, fought Frelimo in the 1977-1992 civil war. This conflict, combined with

the central economic planning by the Marxist leadership of Frelimo left the country in chaos. About a million people died in the civil war.
A new constitution that enshrined free elections was established in 1990 by Frelimo. Both sides signed the resulting Rome Peace Accords of 1992. since then, Frelimo has win all subsequent elections, some of which have been disputed by Renamo and smaller opposition groups.(BBC)

1.1.4 Culture

When reviewing rural electrification programs, one of the mayor reasons of project failure is that their promoters neglect to take into consideration the cultural and social aspects related to that particular community (Globalhood 2007). For this reason, it is important to know and respect cultural and social differences as they may have a great effect in the outcome of our project.

Mozambique has been the home of various different ethnic groups, some of them are Bantu, Swahili, Arabs, Indians and Europeans.

Traditional ways of life are well preserved in Mozambique culture - varying from province to province. This cultural kaleidoscope provides visitors with a host of treasured experiences and memories. The Makonde, from Cabo Delgado Province in the north-east, are known for their fearlessness and initiation rituals. For male initiation, participants dance in 'mapico' masks.
Music is part of the culture of Mozambique and is very important to the Niassa people who live in the sparsely populated north-western region.
The traditional, spicy cooking of Zambézia, Mozambique is highly regarded. Zambézian chicken, grilled with palm oil, is a particular delicacy. The agility of the Nhau dancers of Tete Province is much admired. To the sound of resounding drum beats, they dance holding huge and frightening wooden masks. For the Chope people of Inhambane Province the 'timbila' is both the name of a percussion instrument and a dance. (Mozambique-travel 2012)

Fig 1.4 Mapico mask (Source: http://www.ethnix.com/ebay/120a.jpg)

Regarding religion, the largest/major groups are:

- Christians 56%
- Muslims 18%
- Other beliefs 7%
- No religious beliefs 18%

Portuguese is the official language but Makua-Lomwe, Swahili and other indigenous languages are also well accepted in different regions.

1.1.5 Geography & Climate

The country is divided into two topographical regions by the Zambezi River.
To the north of the Zambezi River, the narrow coastline moves inland to hills and low plateaus, and further west to rugged highlands.
To the south of the Zambezi River, the lowlands are broader with the Mashonaland plateau and Lebombo mountains located in the deep south.

Fig 1.5 Northern landscape
(Source: Authors photo)

The country is drained by five principal rivers and several smaller ones, being the Zambezi the largest and most important.

The country has four notable lakes (all in the north):
- Lake Niassa
- Lake Chiuta
- Lake Cahora Bassa
- Lake Shirwa

Mozambique has an inter-tropical climate with two seasons, a wet season from October to March and a dry season from April to September. Climatic conditions, however, vary depending on altitude.
Rainfall is heavy along the coast and decreases in the north and south. Annual precipitation varies from 500 to 900 mm (19.7 to 35.4 in) depending on the region, with an average of 590 mm (23.2 in). Cyclones are common during the wet season. (Wikipedia (#1) 2011)

1.1.6 Energy

The following is a small brief on Energy resources available in the country:

Resource	Potential	Comments
Wind	Wind resource along coast, Niassa Average wind speed 6 m/s	4 sites studied, resource mapping needed
Solar	4.5-7 kWh/m2/day Surface annual irradiation 1.49 PWh/year	Assuming 5.2 kWh/m2/day Mozambique land surface receives 1.49 PWh/year
Hydro	13 GW. 1000 MW expected to be small scale.	> 60 potential projects

Resource	Potential	Comments
Biomass	In order of 100's of MW. Bagasse potential availably 433 thousand tones.	5 sugar plantations in Maputo and Sofala.
Gas reserves	Estimated 700 billion cubic meters	Could potentially generate 500 MW for almost 400 years
Coal reserves	Estimated 3600 Mt that would be equivalent to 140 million TJ	Could potentially generate 5000 MW for a bit more than 150 years

Table 1.2 Energy Resources in Mozambique
(Source: Hankins 2009; Hellpap, Florian 2011)

According to the International Energy Agency, the country currently the country consumes 10.36 TWh a year. (IEA 2009)

The numbers presented on Table 1.2 are of not accurate and can be hardly compared to each other or to the country's consumption because they do not represent the technical potential but the resource availability. They do not account for conversion efficiency, distribution losses; they even assume that resource can be harnessed completely, which, for example in the case of Solar, would mean to cover the whole country with panels (no space for cities, food crops or anything else).

Nevertheless these numbers are still presented because they represent the most reliable information in terms of energy resource availability in the country.

1.2 Manica

1.2.1 Location

Manica Province is located in the western area of Central Mozambique. It limits in the north with Province of Tete, in the south with Inhambane and Gaza Provinces, in the east with Sofala Provinces and west with Zimbabwe, and it has a total area of 61,661 km², and a population of 1.43 million habitants (INEM 2007).
Manica Province is located in one of the highest areas of the country and gives birth to several rivers that flow east towards the Indic Ocean. (Wikipedia (#2) 2011; Zana 2011) Also, Manica is the gateway with western neighbor Zimbabwe which makes it an important economical center.

Fig 1.6 Manica in Mozambique
(Source: Wikipedia (#2) 2011)

Index	Value	Explanation
Population (millions)	1.438	
Rural Population (%)	74.7	
Life Expectancy (years)	49.1	
Literacy rate (%)	41.5	People of 15 years of age and above
HIV (%)	19.7	Total (% population between ages 15 to 49)
Poverty Index (%)	43.6	Under the national poverty line (2008)
Electrification rate (%)	11.5	Connected to National grid (EdM)

Table 1.3 Synthesis of the main socio-economic indicators
of Manica Province.(Source: The World Bank Group 2011)

1.2.2 Manica Political Division

Administratively is divided in 10 districts:

- Báruè District
- Gondola District
- Guro District
- Machaze District
- Macossa District
- Manica District
- Mossurize District
- Sussundenga District
- Tambara District

Fig 1.7 District location in Manica Province
(Source: GIZ 2011)

1.2.3 Chimoio city

Chimoio is the capital of Manica Province and represents the economical center of Manica. With a total population of 238,976 inhabitants, it occupies the 5th place of the most populated cities in the country (INEM 2007).

Chimoio's name under Portuguese administration was known as Vila Pery. Vila Pery was developed under Portuguese rule as an important agricultural and textiles centre. The change in name to Chimoio took place on 12 June 1975, during the public rally of the first President of independent Mozambique - Samora Moisés Machel.

The town lies on the railway line from Beira to Harare(Zimbabwe), near the Cabeça do Velho rock and it is located about 95 km from the Zimbabwean border.
After the Zimbabwean political and social crisis of the 2000s, Chimoio has become a major destination for immigrants who were looking for work in Mozambique, and today is sometimes described as feeling more Zimbabwean than Mozambican.

1.2.4 Geography & Climate

The province of Manica stretches along the border with Zimbabwe to the west of Mozambique. It is generally characterized by the Vumba, Chimanimani and Nyanga mountain ranges which form the border with Zimbabwe. With a peak altitude of 2436 m , Mount Binga is the highest mountain in the country.
To the east, the province flattens towards its boundaries with Gaza to the south and Sofala to the east. In the north, the soil is more rugged as the province shares its boundary with Tete.

Fig 1.8 Cabeça de Velho - Chimoio
(Source: Authors photo)

Regarding temperature, the highest average per year is above 30 ºC (with peaks of above 40 ºC) and the lowest is around 11 ºC with an average of 22 ºC throughout the year. (Climatedata.eu 2011)

During the rainy season, the rainfall is so heavy that it makes transportation to and/or communication with rural and semi-rural areas almost impossible.

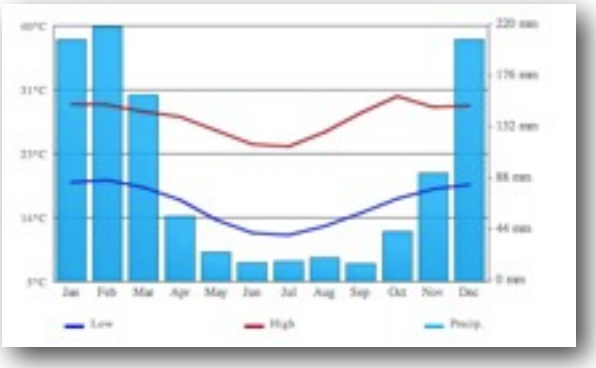

Fig 1.9 Avg.Temperatures and Precipitation in Manica (Source: Climatedata.eu 2011)

1.2.5 Resources

Wind
The average wind speed in the landlocked areas of Mozambique are in general inferior to 2 m/s . Probably there are areas around the mountains with more favorable conditions but no studies have been made to prove it. In a general perspective, the overall province conditions are not favorable for electricity generation using wind power. There are certain specific applications where wind energy could be used, and has been used to a small extent, for example, water pumping. (Klaus 2002)

Solar
Manica has a high solar irradiation level, with a yearly average of 5.4 kWh/day with a monthly variation between 4.2 and 6.3 kWh/day . (Klaus 2002) The amount or energy being harnessed changes from region to region but in general is low.

Biomass
In most cases, the current resource exploitation of fire woods has a devastating effect. Meanwhile, a sustainable usage of Miombo (indigenous tree) of forests and areas of agro-forestry presents high renewable potential for charcoal generation.
On the other hand, compared with other provinces, Manica has a high index of agricultural production. As a result, there is also a high quantity of residuals, both humid and dry, and therefore a good energy potential. In general terms Manica's wood production industry does not explore the energy content on their residuals. Also the biomass potential could be increased by cultivating certain species of grass, woody plants and vegetable oil. (Klaus 2002)
Today large areas are being planted with Jatropha to produce biodiesel following the national objectives for this source of energy.

Hydropower
The mountainous areas on the west show a high rainfall level throughout the year. There are several small and medium sized rivers always reaching a water level that would be appropriate for micro and pico hydropower systems. (Klaus 2002)

A study performed by the World Bank has shown the high potential of the province to generate this type of renewable energy (please refer to chapter 2.2).

1.3 GIZ AMES-M Program

1.3.1 GIZ

The following is a reference from the official GIZ website (GIZ 2010): 'GIZ operates in more than 130 countries worldwide. In Germany, we maintain a presence in nearly all the federal states. Our registered offices are in Bonn and Eschborn. GIZ has more than 17,000 staff members across the globe – some 70 % of whom are employed locally as

national personnel. In addition, GIZ places or finances around 1,110 development workers, 700 integrated experts, 455 returning experts and 820 volunteers worldwide.
The services delivered by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH draw on a wealth of regional and technical expertise and tried and tested management know-how. As a federal enterprise, we support the German Government in achieving its objectives in the field of international cooperation for sustainable development. We are also engaged in international education work around the globe.'

1.3.2 EnDev

The aim of the Dutch-German partnership, Energising Development (EnDev), is to provide five million people in developing countries with sustainable access to modern energy services by 2015. During the first phase of Energising Development (2005–2009) the target was to reach 3.1 million people. The activities of EnDev focus on providing access to modern and clean energy services to poor households, small enterprises and social institutions in rural areas. The energy services include:

- Energy for lighting and household appliances
- Energy for cooking
- Energy for social infrastructure
- Energy for production and income generation

(Zana 2011)

1.3.3 AMES-M

The project "Access to Modern Energy Services-Mozambique - AMES-M", implemented by the German International Cooperation Agency - GIZ, started its activities in Mozambique in the beginning of the year 2007.
The first stage of the AMES-M project lasted 3 years, from early 2007 until ends of 2009. Among the many activities the project was involved in, we can mention:

- Improvement of the electrical grid in the cities of Maputo and Matola,
- Financing 4 small hydropower stations in the province of Manica and,
- The promotion of small solar home systems in the province of Sofala.

(Madeira 2011)

The key objectives for the second stage of the project that extends until 2012 and is mainly focused in the province of Manica are:

- To provide households with modern energy for lighting and small electric appliances to households through Micro / Pico-Hydro, Grid Densification and Battery Charging systems
- To provide with modern energy for productive use by small and medium-sized enterprises, agro-processing cooperatives and craftsmen for employment creation and income generation

- Capacity building of local NGOs, Private Sector, Banks and Partner Institutions (Ministry of Energy, FUNAE)

(Zana 2011)

1.4 Thesis project description

The Excellence Center idea was introduced in joint conversations between GIZ AMES-M and local Universities. The purpose of such a center would be to cover the gap existing between graduating students, which finish their courses with almost not practical skills, and the hands-on expertise that the local companies need in their new employees. The Hydropower Division of the center should train students and young professionals/entrepreneurs in the field of HP giving them the practical skills required to perform field work.

The main objective requested during this thesis was to create the terms of reference for that center. This objective was discussed and accepted by both the director of the PPRE program Dipl. Phys. Michael Golba (on the 17th of June) and Mr. Hans Holtorf (on the 18th of June) who is a professor for of (among other subjects) Rural Energy Supply on the same program. During this last meeting, Mr. Holtorf agreed also in performing the role of main supervisor.

The following is the list of objectives specified by GIZs contract and detailed on several communications with Mr. Dirk van Eijk (Mozambique's GIZ AMES-M program coordinator).

1.4.1 Objective 1

The first objective of my thesis is to analyze existing capability in the engineering fields that are relevant for the hydro sector in Mozambique and particularly in Chimoio city.

Description:

- A set of 4 local universities and 2 technical schools where chosen. Currently they are all the higher education institutions in Chimoio city.
- An analysis of the careers that are related to the HP field is to be done
- The subjects that could be used in the center are to be identified

On a later stage, Universities from around the country could be assessed to have a better picture of the courses being given in relationship with hydropower that could be later used for training purposes.

1.4.2 Objective 2

The second objective is to analyze existing experiences worldwide within GIZ and other stakeholders regarding similar centers for the hydro sector.

Description:
- Contact is to be established between similar projects
- Scope, Structure, Curricula descriptions
- Information from their experience should be obtained
- Courses available and tuition prices per course

1.4.3 Objective 3

The third objective is to analyze and draft a ToR for a potential Training and Knowledge Centre. The output should be trained practitioners capable of scouting, system design (civil,electromechanical) , construction/building, operation, maintenance, service and potentially: project development, management and financing.

Description:
- The ToR should be hands-on oriented, that is, the goal is build on practical skills in the field of HP, which, as from current universities courses structures, are missing.
- A description of the organizational structure of the center: Who does what and how.
- Scope and justification showing clearly why the center is a good idea to Ministries and investors
- Basic curricula draft and timeline for individual trainings

1.4.4 Objective 4

The last objective of the thesis project is to prepare a draft of an investment proposal and training program for the institutions and people (teachers/professors) involved. Prepare the training program abroad when necessary.

Description:
- Based on the knowledge update needed for instructors, an investment proposal should be made to cover that gap abroad or bringing an expert without considering the travel expenses
- A basic equipment investment proposal should be performed

2. Research

2.1 Research Methodology

According to the Merriam-Webster Dictionary, a methodology is 'a body of methods, rules, and postulates employed by a discipline : a particular procedure or set of procedures' used to achieve a certain goal (Merriam-Webster 2012).

In the particular case of this thesis work, the main objective was to create the Terms of Reference document describing the Excellence Center and its Hydropower Division. The methodology to create a training center cannot be applied as writing the ToR is but a single component of the whole process, and, in any case, there is not standard methodology used for such objectives.

On the other hand, training centers abroad were contacted (Unido Abuja in Nigeria, IN-SHP in China) to obtain a standardized methodology and format for the creation of the ToR document, and it was found that non of them had prepared it. It seams to be often the case that on projects such as the creation of institutions like a training center (or an excellence center), the promotors of the idea follow their own approach as there are no international standard mechanisms.
Some steps are being followed to solve these issues as agencies like Institute for Sustainable Power with its International Standard program (ISPQ 2010) and International Energy Agency with its Hydropower agreement (IEA 2009) get involved.

As there is no agreed-upon approach, the author used a simple methodology that gives quick results. The approach is divided into 5 steps which are described underneath.

- Data Collection - gather the required information for the creation of the document
- Data Analysis - analyze that information and understand how stakeholders will come together
- Document Preparation - write the requested documents
- Evaluation - evaluate along with GIZ and the universities
- Wrap Up - finish and deliver

This thesis project was performed during a six-month period as agreed with GIZ AMES-M.

2.1.1 Data Collection

The data collection stage involves not only literature and Internet research, but also meetings with the stakeholders, which may underline the possible linkages of each other with the center. Also at this stage, communication was established with similar projects around the world in order to understand the way others planned their centers and how did they solve similar problems.

Some of the methods used to gather information were:

- Workshops with stakeholders
- Individual meetings
- Email and Telephone contact with institutions abroad
- Internet literature
- Email and phone with stakeholders
- Document from past/present projects

2.1.2 Data Analysis

With all the data gathered from the previous stage, the analysis will be done to define the scope and limitations, the Institution who would take the leadership and what will the organizational structure look like. It will also provide a possible physical locations, identify risks and barriers, and contribute to the preparation of an investment draft.

2.1.3 Document Preparation

The document preparation consists in writing down all the results from the data analysis stage into the required documents. These are:

- *Terms of Reference* - defines the structure and objectives of the center of excellence (refer to appendix A1)
- *Suggested roles* - define which stakeholder should take each role (refer to Annex A4)
- *Capability Analysis* - shows the current courses and possible linkages of individual subjects to the center (refer to chapter 3.3 Capabilities)
- *Investment Draft* - gives and idea of the investment needed to establish the center (refer to chapter 3.6 Investment)
- *Memorandum of Understanding* - establish the will of the universities to come together for the establishment of the center (refer to Annex A5)
- *Master Thesis Document* - this document
- *Master Thesis Presentation* - summary of the master thesis document

2.1.4 Evaluation

At this stage, all stakeholders will be requested to check the documents that concern them and make suggestions or corrections.
This process will take some time and it will be recursive. As new versions emerge, they will have to be reviewed until finding consensus.

2.1.5 Wrap Up

With the complete agreement from the Actor's side, details will be finished and final documents delivered to GIZ AMES-M, the University of Oldenburg and every Stakeholder.

2.2 Hydropower Potential

Although there is no internationally agreed definition of "small" hydro, the upper limit is usually taken in line with the World Commission on Dams as 10 MW of installed capacity. Within the range of small hydro, a distinction can be made between Small, Mini, Micro, Pico HP setups (<15 MW , <1 MW , <100 kW , <5 kW respectively) each with its own technical characteristics.(Practical-Action 2009; GIZ 2011)

A World Bank study has shown (WorldBank 2007) that the potential hydropower generation in Mozambique is substantial. About 13000 MW , producing 65000 GWh/y of energy, can be economically developed in Mozambique. About 70% of this potential (10000 MW , 45000 GWh/y) is concentrated in the Zambezi watershed, most of it on the Zambezi river which includes the provinces of Manica, Niassa, Zambezia and Tete. From that potential, 1000 MW belong to the Mini, Micro and Pico generation schemes.
It is worth noting that for the potential of 13000 MW of power to produce 65000 GWh/y of energy, the setups should run in full load for approximately 5000 h/y. The ratio of the actual power output to the potential output if it had worked throughout the year at its nameplate capacity (Capacity Factor) is in this case:

$$CF = \frac{(65000\ TWh)}{365\ \frac{days}{y} \cdot 24\ \frac{hours}{day} \cdot 13000\ MW} = 0.57$$

Equation 2.1 Capacity Factor

Which for Hydropower setups seams slightly high (U.S. Department of Energy 2002). In particular considering that, in Mozambique, most parts for replacement need to be imported and that would increase down time.

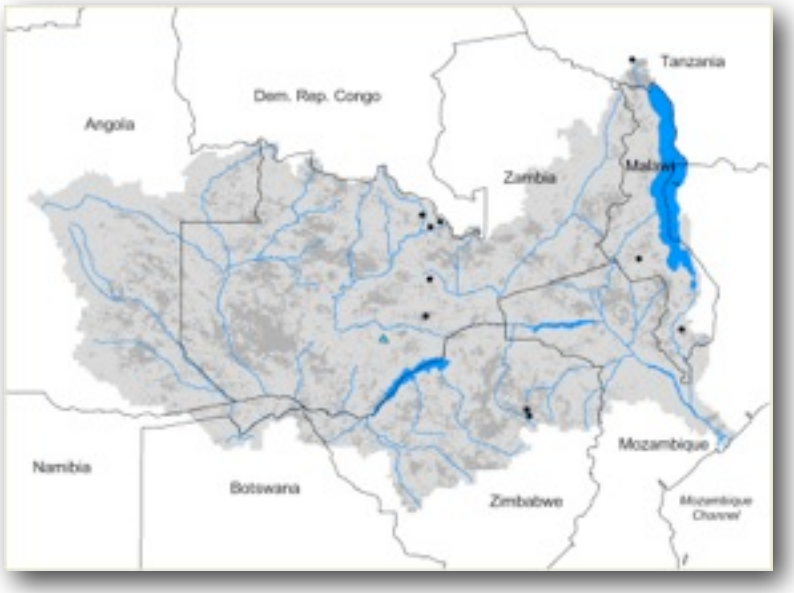

Fig 2.1 Zambezi watershed
(Source: World Resources Institute 2006)

The importance of the Zambezi watershed (Fig 2.1) needs to be stressed as it is due to this geographical characteristic of the region that the hydropower potential exists.

GIZ AMES-M working along with AKSM, DIPREME-DE, FUNAE and other partners has identified more than 70 potential sites to develop this technology in rural areas of Manica province, some of which have already been developed or are in the construction phase.

2.3 Policies and the role of the Government

From the year 2000 forward the Mozambican Government has given increasing support to the development of energy options for rural areas and to the role that renewable energies should play in the country's energy matrix. Plans for setting pilot setups along with private companies date from that year.

Documents such as 'Política de Desenvolvimento de Energias Novas e Renováveis' from the Ministry of Energy or laws such as nº 21/97 (electricity generation), nº20/97 (sustainable development of Mozambique), nº 5/95 (environmental policy) and nº16/91 (hydro resources management) show support from the government in the field.

Nowdays, Manica branches of governmental institutions like DIPREME-DE have projects such as: "ENERGIA RENOAVEIS E NOVAS FONTES-GERACÃO DE ENERGIA HIDRICA - 2011" whose main objective is to expand the energy supply systems to rural areas so as to benefit at least 2,000 people, always pursuing an increasing expansion in the hydropower field. (DIPREM 2011)
FUNAE's plans for 2012 have among its objectives to supply more than 830,000 people with electricity coming from a RE source, from which 13,000 are from 9 Mini-HP set-up projects that will take place in Manica. (FUNAE 2011)

2.4 Higher Education Institutions and students

Originally, the idea of the Excellence Center was conceived in conversations with Universities. They are trying to expand their options for future professionals in more practical areas which would allow the students to have a faster market insertion after graduation..

Even further, from the first day on, they have shown their commitment in every meeting by pushing with comments and ideas, and GIZ AMES-M's increasing efforts continuously grow their excitement as well.

Considering that most universities offer in their curricula a range of optional subjects from which students choose according to their preference and interests, the center could receive these students and train them in subjects related to HP development.

Interest has been shown by students from UP in an exercise performed by GIZ AMES-M offering a six-hour seminar in Renewable Energies; and even though only students from 1st and 2nd year of Chemistry, Physics and Mathematics were invited, a total of 170 students assisted. This gives and idea of how curious future professionals can be in these subjects.

Moreover, these subjects are intended not only for students, but also for professionals looking for actualization, NGO employees, private companies, Government employees, among others. Many of whom have already showed interest in being trained in subjects related to HP.

Also, currently the ECHD is planned to target trainees from Manica province, but as it grows, the scope will turn national and maybe even international.

At the current stage of the project, quantification of the number of future trainees is not possible. It is expected that during the start-up of the project, this information will be more easily obtained, in particular while the pilot trainings occur (see chapter 3.5 implementation Plan).

2.5 Catalyzer

The catalyzer is the organization that observes the resources and capabilities in a region, identifies the markets that could be developed and finally, invests time, money, personnel, etc. in a project that would bring all together.

In this case the catalyzer for the project is GIZ AMES-M that, working hand in hand with local universities, NGO's, governmental agencies and private companies, is aiming at building the local capacity in the area of (small)hydropower. The program that addresses this issues is "Scaling-up Pico and Micro Hydropower in the Province of Manica Mozambique - 2011".(GIZ 2011)

The catalyzer is an external organization because even though the idea of a training center had been discussed before by the universities, there wasn't a clear idea of how to start or who would play which role. After identifying this, GIZ stepped in and, in accordance with their core business and alined with their capacity development objectives, decided to start with the creation of a Terms of Reference that would provide the structure and the roadmap to its creation. (Dirk van Eijk Feb 2012 - email comment)

2.6 Stakeholders Analysis

A stakeholder (or actor or player) is an individual, organization or group who has a role to play and/or is affected by the outcome of an issue, situation or process. (Jan Ubels, Naa-Aku Acquaye-Baddoo and Alan Fowler 2010)

Based on discussions with GIZ AMES-M, the Excellence Center and its Hydropower Division will have different stakeholders, where each one will play different roles according to their capabilities. They can be grouped as shown in Fig 2.2.

From the meetings with the stakeholder, it was essential to gather information regarding what they do, and what the possible linkage with the center could be.

It was of importance also to identify what could their role be in the center. Therefore, notes were taken regarding their interest in the project, how could they contribute, and for example, in the case of Universities, the courses given and how could they be related to the objectives of the center. Later on, this information helped to stratify them in such a way that the ones more involved to the hydropower area could be leading the center.

The groups of stakeholders are:

- Higher Education Institution
- Governmental agencies
- Development Organization
- NGO
- Financial Institutions
- Public Companies
- Private Companies
- Instructors
- Trainees
- Community

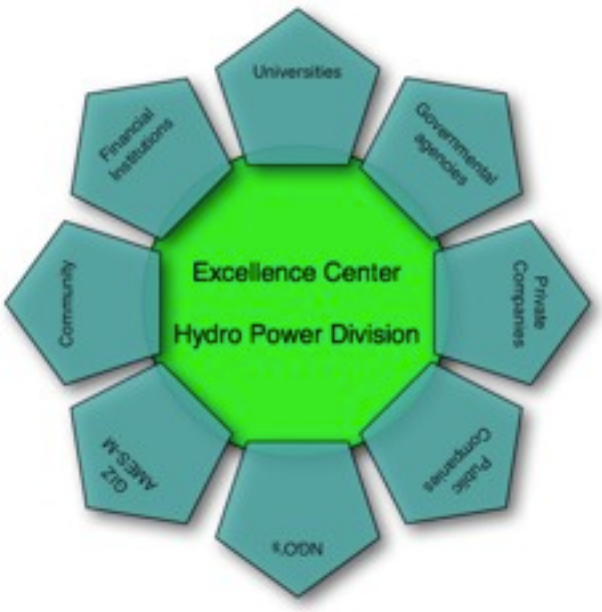

Fig 2.2 Stakeholders and the ECHD
(Source: Mr. Zana Crispen)

3. Results

3.1 Stakeholders description

Cooperation and interest was measured by their response, not only during the meeting but also in the time and manner they provide the requested documents, their approach when organizing the meetings, and so on.
Due to the nature of the interaction with the stakeholders (mostly one to one communication), it was very difficult to quantify the results of those interactions. For that reason and to maintain and standardized analysis format, the evaluation gradients were selected as follows:

Commitment from higher level
HIGH: The Director showed high predisposition and energy towards the project
MEDIUM: The Director showed some interest but had doubts about the project
LOW: The Director showed little interest and energy towards the project

Cooperation during project analysis
HIGH: Meetings were kept, good email communication and the documents were provided upon request
MEDIUM: Meetings were usually kept, fair email communication, and of the requested documents were provided
LOW: Meetings were often canceled, poor email communication and documents never provided

And for Table 4.2, the gradients are:
General Cooperation (joins commitment from higher level and cooperation during the project)
HIGH: Director highly interested and energetic, meetings kept, good communication and documents always provided.
MEDIUM: Director interested but with some doubts, meetings usually kept, fair communication and some documents provided.
LOW: Director not as interested, meetings usually canceled, poor communication and documents never provided.

Relationship between courses taught and the ECHD
HIGH: Several courses or subjects within a course are strongly related to the ECHDs objectives
MEDIUM: Some courses or subjects within a course are related to the ECHDs objectives
LOW: Few or non subjects or interest to the ECHDs objectives

In every case, NA means not information available.
The following is a summary of the main information from every actor:

Stakeholder	Type of Stakeholder	Commitment from the Higher level	Cooperation during the project analysis	Proposed Contribution	Expected benefits
UP	Higher Education Institution	HIGH	HIGH	• Professors • Classrooms and physical space • Time and personnel	• They can extend the amount of options for their students • Future facilities to do research • Better labs and teaching materials
UniZambeze	Higher Education Institution	MEDIUM	HIGH	• Professors • Classrooms and physical space • Time and personnel	• They can extend the amount of options for their students • Future facilities to do research • Better labs and teaching materials
ISPM	Higher Education Institution	MEDIUM	LOW	• Professors • Classrooms and physical space • Time and personnel	• They can extend the amount of options for their students • Better labs and teaching materials
UCM	Higher Education Institution	HIGH	LOW	• Professors • Classrooms and physical space • Time and personnel	• They can extend the amount of options for their students • Future facilities to do research • Better labs and teaching materials
Joaquim Marra	Higher Education Institution	HIGH	LOW	• Professors, • Classes on how to build generators, • Classrooms.	• Training in the field for professors and student • Using the labs to perform their practices • Maybe sell some generators
ESEG	Higher Education Institution	LOW	LOW	• None at this stage	• Students would like to have practices of the things they learn • It would allow students to see other options when they graduate • Students could specialize in these fields

Stakeholder	Type of Stakeholder	Commitment from the Higher level	Cooperation during the project analysis	Proposed Contribution	Expected benefits
DIPREME	Governmental Agency	HIGH	MEDIUM	• They can provide part of the legal framework when it comes to energy and electricity	• The center would contribute in the long term to meet their objectives in rural electrification
DPOPH	Governmental Agency	HIGH	MEDIUM	• Knowledge of construction with different materials • Technical knowledge of constructions in general	• They want every regional employee (SDPI) to be trained in order to spread knowledge to the communities about HP
ARA-Centro	Governmental Agency	HIGH	LOW	• Advice on technical aspects • Water derivation and channeling • Legal framework • Measurements of water flow in different areas • Instructors	• Their business is water, if the amount of HPP increase is better for them • They would like that the center creates and maintains a database of the stations available (contact info, size, production, etc) to have a 1 point to accumulate all knowledge
FUNAE	Governmental Agency	HIGH	MEDIUM	• Share their experience in the field • Give some lectures • They advice that we make it very practical but with local experiences	• Trained professionals • Projects done by the graduates will help them reach their the electrification rate targets
Metalúrgica	Private Company	HIGH	HIGH	• They can provide hands-on training • Some lessons can be given at the workshop • They own machinery that could be used on the early stages of the project • They offer their experience • Instructors	• Trained people for Maintenance & Operation of the turbines they sell in the communities • Trained people in the area of business and finance which will help the market to grow faster • Training on request. After hiring a new employee they would like to have him/her going to the center to be trained for them
AKSM	NGO	LOW	LOW	Not available	Not available

Stakeholder	Type of Stakeholder	Commitment from the Higher level	Cooperation during the project analysis	Proposed Contribution	Expected benefits
EDM	Public Company	LOW	LOW	• Experienced workers to teach and share their experiences • Instructors to teach subjects that are currently given in their training center	• Trained professionals to be hired by EDM
Banco Terra	Financial Institutions	MEDIUM	MEDIUM	• They can provide training on how to prepare a business plan • They can provide advice on the financial analysis of projects	• The center will raise awareness about this technologies in communities, and therefor, the number of clients brining projects to the bank would also increase
GIZ AMES-M	Development Organization	HIGH	HIGH	• Time and personnel • Financial contribution to prepare labs • Instructors	• The realization of such a training center would help GIZ AMES-M achieve their Capacity Building objectives, • With more trained professionals on the field, the access to energy of disperse communities will also increase.
Instructors	Instructors	NA	HIGH	• They will bring their knowledge and experience to the center	• Update in different fields • They would be connected with others on the area
Trainees	Trainee	NA	HIGH	• Their experience in rural areas • Money to pay for the courses	• Increased professional spectrum • Gain a practical knowledge not given anywhere else • Easier (self)employment
Community	Community	NA	HIGH	• The community provides the physical place and the people • Local available knowledge and experience	• Higher employment rate for the community • Increased general income • Faster development

Table 3.1 Actor's Description

Is worth noting that in most cases, the commitment from the higher level is higher than the real cooperation. This was mostly because the first was measured on the response of the Director in one or two meetings which did not take a lot of time or effort from the

side of the stakeholder. While cooperation always involved preparing and sending documents, visits, and so on, which were more time consuming and required more effort. Table 3.1 is descriptive and no further information can be drawn from it.
If we consider only the institutions of higher education, we can get a better representation on the important information that was obtained from them:

Stakeholder	General cooperation	Would take the leader role	If someone else was the leader	Relationship between courses taught and the ECHD	Physical location available	Perceived capacity as leader
UP	HIGH	YES	UNWILLING	HIGH	YES(2013)	VERY HIGH
UniZambeze	HIGH	YES	OK	MEDIUM	YES	HIGH
ISPM	LOW	YES	OK	LOW	YES(mid 2012)	MEDIUM
UCM	LOW	YES	OK	HIGH	YES(2012)	HIGH
Joaquim Marra	MEDIUM	NO	OK	HIGH	YES	LOW
ESEG	LOW	NO	OK	LOW	NO	LOW

Table 3.2 Main Actor's important information

From Table 3.2, several results can be extracted. UP, UniZambeze and UCM become clear main stakeholders on the center, as they show high cooperation, interest of leading the project, related courses to the ones that will be given by the center and high perceived leadership capacity.
Also it can be seen that the availability of physical space will not be a problem as all of them have shown willingness of sharing their locations.
Finally, Universidade Pedagógica clearly stands up among the rest as a clear leader. This was taken into consideration establishing the roles each one should play.

For a detailed description of the stakeholders and their relationship with the project, please refer to Annex A2.

3.2 Risk Assessment

Risk assessment in a non-technical project is comparable to error analysis in an experimental one since it allows to see possible deviations from the expected results as well as identify dangers and risks jeopardizing the desired outcome.

When performing a technical evaluation, it is important to understand that measurements are always subjected to uncertainties and errors. Understanding their nature and magnitude allow to draw valid conclusions from those measurements.
The same way, in a non-technical project, it must be accepted that there are risks and uncertainties that should be evaluated, their nature and impact understood, and, when possible, preventive measurements taken to diminish their effect in the final outcome.

When analyzing the feasibility of any project, a risk assessment needs to be done in order to identify the internal and external risks of the project that could endanger its success.
The analysis should be detailed enough to account for any possible risk with a major effect in the outcome, but, at the same time, not depth enough to make an infinite list of risks.

For this project's risk assessment, two main strategies were followed:

- *ECHD risks*: we tried to identify what are the main issues that could cause problems using a Strength, Weaknesses, Opportunities and Threats (SWOT) analysis approach.
- *Stakeholders success factors*: using a different perspective, we considered every stakeholders's idea of success regarding all the problems that could stop them from achieving their goals.

3.2.1 Excellence Center Hydropower Division

SWOT analysis is a strategic planning method used to evaluate the Strengths, Weaknesses/Limitations, Opportunities, and Threats involved in a project or in a business venture. It includes specifying the objective of the business venture or project

and identifying the internal and external factors that are favorable/unfavorable to achieve that objective. (Global Standard 2009; Wikipedia (#3) 2011)
In the case of the ECHD, the following factors were identified:

Fig 3.1 SWOT Analysis of the ECHD

Strengths

- ***Strong knowledge*** - Organizations willing to share their experience have been running projects for a long time.
- ***Strong support from main stakeholders*** - All higher education institutions showed commitment and interest in every meeting
- ***Proactive staff*** - University and organization's staff brought new comments and ideas
- ***Stakeholders with experience in the field*** - Organizations like GIZ have been participating in projects during many years.
- ***GIZ driving force at the first stages*** - GIZ is a strong partner to the center as it is an organization that strives to get projects running and it has an enormous network of people around the world related to the HP field
- ***The stakeholders have worked together in the past*** - Universities in particular have worked together in other projects and they have good relationships.

Weaknesses

- ***No previous experience in such a center or similar endeavors*** - Universities have not been involved in the development of a similar center before.

- ***Small initial budget, only for lab equipment*** - There is not set budget for the establishment of the center, but the stakeholders expressed that the lack of funds may be a problem. GIZ mentioned that they would provide for the lab equipments needed.
- ***No dedicated physical space*** - There is not a building to be used exclusively for the center.
- ***No dedicated Instructors*** - Instructors are also teachers in their respective universities.
- ***Could loose momentum if a main stakeholder leaves*** - Specially in the beginning, the center establishment will depend strongly in the individual stakeholders.

Opportunities

- ***Large hydropower resource*** - As described in chapter 2.2, the hydropower resources in the area are high.
- ***Large potential trainee market*** - Students in the city lack practical skills and often find that there is a big gap between what the employers need and what university teaches them.
- ***Only center on HP in the country*** - The ECHD will be the first center of its kind in the country. There are similar facilities but they are privately owned and are used for training personnel from their own companies.
- ***Potential partnership with other similar centers*** - Building a network with other centers abroad will allow the ECHD to grow and to expand its options.
- ***Funding possibilities may be available abroad*** - When looking for expansions, exploring new fields or doing research, international organizations such as GIZ, the World Bank, among others, could be asked to participate financially.

Threats

- ***The opening of similar centers*** - If similar training centers would open in the surrounding region (Zimbabwe, Malawi, South Africa, Swaziland, etc) targeting the same group, it could endanger the future of the center
- ***Not proper awareness in the communities*** - Communities are not usually aware of the potential benefits of the technology
- ***Economy downturn could make HP projects too expensive or less interesting for their establishment or local production*** - In countries with less strong economy, it may happen that an economic downturn would negatively affect this and many other industries.
- ***Government taxes for SHP schemes can make projects too expensive*** - Currently no taxes are applied for small hydropower schemes, if that would change, it may render projects economically not interesting
- ***Limited finance for such projects*** - Currently financial institutions are not interested in small hydropower schemes.
- ***Legal regulations on education by the Ministries*** - The creation of the final curricula for the courses needs to be approved by the Ministry of Education.
- ***Rotation of teachers (instructors) can endanger the Division*** - University teachers tend to rotate among jobs in different cities when they are offered better compensation.

It is highly important for Stakeholders to understand this factors and to always keep them in mind, to benefit through the centers' strong points and to avoid the negative effects of the weaknesses and threats.
Even when the previously given list represent the main strengths, weaknesses, opportunities and threats that may affect the centers establishment, new influences may appear in the future and this list should be re-examined after every stage of the implementation plan.

Once we have identified which are the ECHD's weak points, we can establish ways to avoid or diminish their impact.

Suggestions to minimize weaknesses

- **No previous experience in such a center or similar endeavors:** Establishing strong bonds with other similar centers abroad to get their support if needed
- **Small initial budget, only for lab equipment:** By starting in small steps, the budget required should not be high
- **No dedicated physical space:** Universities have agreed in sharing/lending space for the courses to take place
- **No dedicated Instructors:** Having a very well designed schedule for Instructors will contribute in diminishing conflicts with their other responsibilities
- **Could loose momentum if a main stakeholder leaves:** Stakeholders should not be essential enough to compromise the center's performance if they decide to leave. All positions should have more than one potential candidate.

Suggestions to minimize threats

- **The opening of similar centers:** Taking advantage of being the first ones by building strong bases in the field while no competitors are available locally and regionally.
- **Not proper awareness in the communities:** Marketing channels will have to be established to promote the technology and its usage.
- **Economy downturn could make HP projects too expensive or less interesting for their establishment or for local production:** By using mostly locally manufactured equipment the negative effects could be diminished. Local enterprises should be invited to visit projects and encouraged to jump into the field. By including some PUE in the projects, and as selling remains high, local production would continue.
- **Government taxes for SHP schemes can make projects too expensive:** Establishing good network with Governmental Agencies, making them take part of the project, and showing them what the impacts are in the communities.
- **Limited finance for such projects:** By enhancing financiers' knowledge about the potential markets, more options on financial stream could be open.
- **Legal regulations on education by the Ministries:** By working together with Universities and Ministries, the courses curricula would be written in such a way that it will take in consideration Mozambican teaching laws.
- **Rotation of teachers (instructors) can endanger the Division:** This could be solved by establishing clear rules for the future instructors' selection, by giving them the propers stimulus to stay, and by preparing formal obligatory contracts in between them and the ECHD.

As it can be seen, there have been identified several threats and weaknesses that may negatively affect the centers establishment. Nevertheless, by following the suggestions described above, their impact in the final outcome can be largely diminished.

As it has been expressed before, this list may not be exhaustive and as the process of implementation starts, new threats and weaknesses may be identified. They should be added to the list along with suggestions on how to avoid/diminish their negative effect.

3.2.2 Stakeholders

In order to identify what the risks that could endanger the ECHD's ability to achieve its goals are, we need to understand what every Stakeholder wants to obtain from it and even further, which are the factors involved for that to happen. Therefore, the following self-set goals, success factors and indicators are related to the objectives the stakeholders expect to achieve through the Hydropower Division.

In our analysis, success factors and failure factors are joint together under the name of the first by assuming that a success factor is any external event that influences the accomplishment of the self-set goals either positively or negatively.

To do so we applied a conceptualized model of success for SHS developed by Mr. Holtorf and a team from Murdoch University in Australia(Hans Holtorf 2011).
This methodology has been used to analyze projects in a post-development stage (either failed and closed, or still working), but in our case, it was used in a slightly different manner, we tried to foresee any factors that could boost or endanger the stakeholders' achievement of goals in a project that has not been done yet.

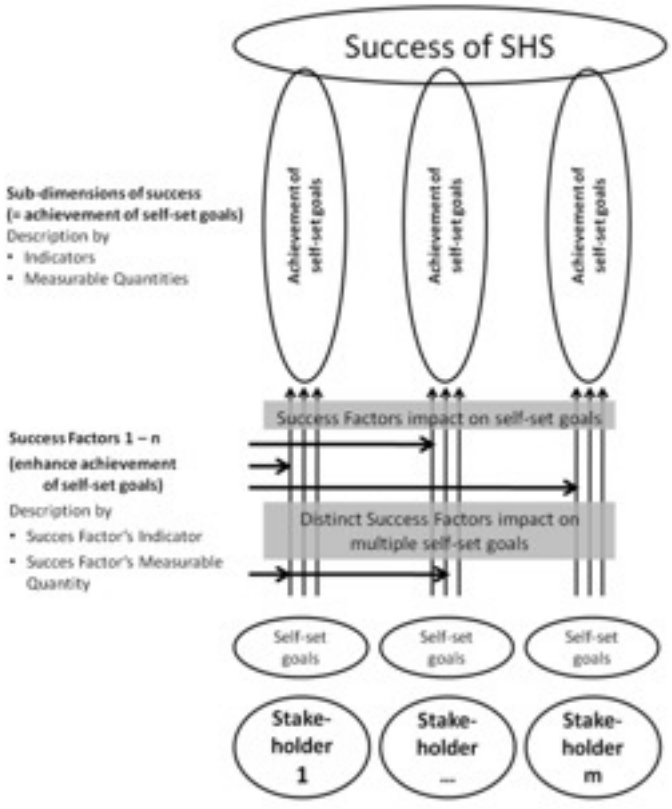

Fig 3.2 SHS Success Analysis Methodology
(Source: Hans Holtorf 2011)

As goals are shared by similar institutions we have grouped them to perform the analysis. For the ECHD's stakeholders, a list of their Self-Set goals and Success factors is given bellow including possible indicators that measure the project's evolution towards individual goals:

Entity	Self-Set Goals	Success Factors	Indicators
Higher Education Institutions	To be more attractive to present and future students To train their staff To have research facilities for advanced courses To improve networking with other Universities	Funding availability New educational options may appear targeting the same market There may be differences between the members of the project. Economical fluctuations at country level Readiness of partner institutions to network and cooperate	Increased enrollment of students Decreased number of students abandoning the career Lowered staff rotation Increased advanced courses done per year
Governmental Agencies	To increase electrification rate To bring economical growth through employment and business opportunities To get public recognition through positive outcomes of the projects	People relating the idea of RE projects and government policies Economical fluctuations at country level Political stability	Higher electrification rate More votes in election Increased Employment, Agricultural and Commercial indexes of development (INEM 2007)
NGOs and Development Organizations	To achieve goals on development To support economic development Higher level of welfare for people serviced Established training centre for the (micro) hydro sector in 1-2 years time	Cooperation from the involved partners Economical fluctuations at country level Change of focus from organization's higher level Relationship with other organizations	Stages outputs for the training center being completed Increased economical indexes for the region Higher consumption of equipments related to HP setups
Private and Public Companies	To make profit To increase their market share To get professional employees	Economical fluctuations at country level Low amount of competitors Motivation of employees	Increased amount of units sold Sustained or increased market share Lower employee rotation

Entity	Self-Set Goals	Success Factors	Indicators
Instructors	To have a higher salary and/or better benefits To update their knowledge through training	University recognition of their importance Other positions being offered Economical fluctuations at country level Trainee's interest in the center	Lower Instructor rotation Increasing numbers of enrollment to the courses
Trainees	To make money To get employed faster To specialize in a new field To increase their learning opportunities	Economical fluctuations at country level Enough money and time to do the courses Other learning options available	High level of employment of graduates Increased enrollment in the courses Requests for new courses
Community	To be economically more stable To increase the level of employment To give opportunities to youngsters To increase level of education	Economical fluctuations at country level Food or water availability Opportunities in other cities may attract young people	Increased access to water Increased food availability Decreased number of young people leaving their community Creation of small local enterprises related to HP

Table 3.3 Self-Set goals, Success factors and Indicators for every stakeholder

3.3 Capabilities

As part of the objectives, a Capability study had to be performed in the fields of Engineering and Environmental sciences in Chimoio and if possible at country level to evaluate where does Mozambique stand in the field of HP and how could Institutions collaborate in the development of the Excellence Center.

Later attempts to involve the Mozambican Ministry of Education proved to be unsuccessful and therefore the study shows results in the Chimoio city.

The institutions queried were:

- Universidade Pedagógica
- Universidade Católica de Moçambique
- Instituto Superior Politécnico de Manica

- Universidade Zambeze
- Escola Superior Joaquim Marra
- Escola Superior de Economia e Gestão (ESEG)

The result of this study can be observed in the following table:

City	Institution	Course	Linkage to ECHD
Chimoio	UP	Bachelor in Biology - Minor in Laboratory Management - Minor in Chemistry teaching	NONE
Chimoio	UP	Bachelor in Education Management and Administration - Minor in Education and Community development	NONE
Chimoio	UP	Bachelor in Environmental Management and Community Development - Minor in Ecotourism	LOW
Chimoio	UP	Bachelor in Mathematics Teaching	NONE
Chimoio	UP	Bachelor in Chemistry - Minor in Laboratory Management - Minor in Biology teaching	LOW
Chimoio	UP	Bachelor in Human Resource Management - Minor in Security and Hygiene in the work environment	NONE
Chimoio	UP	Bachelor in Agriculture and Livestock teaching - Minor in Rural extension	NONE
Chimoio	UP	Electrotechnical Engineering(2012)	HIGH
Chimoio	Uni Zambeze	Environmental Engineering - Minor in Natural Resources and Environmental Management - Minor in Environmental Technologies	MEDIUM TO HIGH
Chimoio	Uni Zambeze	Rural Development Engineering - Minor in Sustainable Management of Rural Areas - Minor in Territorial Development	MEDIUM
Chimoio	UCM	Food Engineering	NONE
Chimoio	UCM	Civil Engineering	HIGH
Chimoio	ISPM	Agricultural Engineering - Minor in Agro-Business	NONE

City	Institution	Course	Linkage to ECHD
Chimoio	ISPM	Ecotourism and Wildlife	NONE
Chimoio	ISPM	Forestal Engineering	NONE
Chimoio	ISPM	Zootechnical Engineering	NONE
Chimoio	ISPM	Accounting and Auditing	MEDIUM

Table 3.4 Courses given by each University and their importance to the ECHD

As established by one of the objectives requested by GIZ, it was necessary to identify the courses given by the individual universities that could be somehow related to the future courses of the ECHD. Table 3.4 shows each course with the expected linkage to the center. The gradient used to evaluate them is given underneath:

HIGH: Most individual subjects in the course are related or can be used by ECHD
MEDIUM: Several individual subjects in the course are related or can be used by the ECHD
LOW: Almost no subjects in the course are related or can be used by the ECHD
NONE: No subjects of the course are related or can be used by the ECHD

This information is important because it was used along with the rest of the stakeholders data (Table 3.2) to select those institutions which had more at stake with the project.

Both ESEG and Escola Superior Joaquim Marra were unable to provide their courses curricula.

3.4 ToR description

'The Terms of Reference describes the purpose and structure of a project, committee, meeting, negotiation, or any similar collection of people who have agreed to work together to accomplish a shared goal.' (Wikipedia (#4) 2011)

The ToR is the outcome of the interests and expectations for the ECHD expressed during several meetings by the individual stakeholders.
The document is outlined next (PMAdvice), each item is described and the reasons for individual decisions are explained.
The complete ToR document can be found in Appendix A1 of this paper.

Introduction
Explains what the ToR document is and how was conceived.

Purpose

This section describes the gap that the Hydropower Division of the center will cover and it gives a brief explanation of the main goals to be achieved.
These goals come as a result of many discussions held with the stakeholders.

Initiated by

Describes who initiated the idea and was involved since the first stages of the project conception.

Background

-- Context

This section defines the context in which the ECHD is being considered, which includes the availability of resources, the proper political framework and eagerness from the stakeholders to push this endeavor forward.

-- ToR

Under this section the need for a ToR is explained along with the benefits of having such a document.

-- Excellence Center

Originally the name was established as "Training Center for (small)Hydropower in Chimoio". Even though it reflects very accurately the current objectives of the center, during the meetings with the stakeholders, it was clearly stated that it should allow the possibility of future growth into other technological areas such as PUE, Solar Energy and Biomass.
Under this premisses the name Chimoio's Excellence Center was proposed and the Hydropower Division is described under this document. This gives flexibility to the structure without further complexities, and as market or objectives dictate, new divisions could be created by duplicating the structure and selecting a new Superior Executive Council for it.

Objectives

This section synthesizes the objectives established, so an explanation of each one is given under the *Deliverable* section . These objectives represent the interest of the different stakeholders in the ECHD.

Training Center: This was the main objective since the idea was proposed. The Hydropower Division should be capable of training students and professionals in all the different tasks involved in a small HP project, from management to constructing using local materials.
Knowledge Center: In several occasions it was expressed that the need for a knowledge base was high and that this center should cover it. This knowledge base should gather available information, research, documents, and so on, relevant to the field.

Contact Point: Different players in the SHP field are scattered in the province and the country. A single contact point will contribute to achieve higher outcomes through coordinated efforts.
Research Center: The Higher Education Institutions have repeatedly expressed their need for a place to run experiments and do research for advanced courses. In the area of SHP, the Division should provide it.
Expert consultancy: The ECHD should be able to provide advice to the Government and other Organizations in technical/economical aspects regarding this type of projects.

Scope

The scope draws the limits of the center. It basically establishes boundaries that will contribute to simplify the project.
These boundaries are:

-- Language
We chose the language to be Portuguese. The reason for this is that it represents the official language of the country and, English is not widely spoken among students or teachers. If we chose to establish the latter targeting an International market, the main goal, which is to prepare local students and professionals, would be lost.

-- Geographical Market
The geographical market should initially be considered as small as possible. This will result in a more controlled start and will also allow learning and correcting the approach as time passes. Lunching on a larger scale without having any previous experience, would increase the likelihood of failing.
The proposed market growth steps are:

- Chimoio City
- Manica Province
- Mozambique
- Regional

No time line is suggested because the growth should happen naturally as stakeholders and participants become more confident and experienced.

-- Project sizes
The final objective of the center is to prepare people to tackle community problems through the usage of the SHP technology. Large projects tend to be very complicated and inefficient in countries such as Mozambique were the population is highly scattered.

For this reason, the center will focus its efforts in preparing professionals to develop small projects that have faster, of easier to implement and require small budget. In sizes they can be classified as Small, Mini, Micro, Pico HP setups (<15 MW , <1 MW , <100 kW , <5 kW respectively).(Practical-Action 2009; GIZ 2011)

-- Physical location

The project does not consider to build or acquire a facility during the first years, therefore, locations will be provided by the the partners involved.
Institutions may choose not to give free access to their facilities**, for that reason a fee can be considered to be paid to the owner. That sum of money should be small and used to maintain the physical location and the equipment/material there.
In case of more intrusive usages, such as building a laboratory, formal contracts for longer periods should be signed by both the ECHD and the facilitator in order to ensure that the investment done is not lost

In any case contractual obligations should exist to ensure that neither party takes advantage of the locations or uses them in an inappropriate way and they should specify warranties, costs, duties and responsibilities of the partners involved during the period of time the contract is valid.

-- Finance

The center financial objective is self-sufficiency. That is, on the day-to-day activities, the ECHD should not require external funding to function i.e. the trainings it provides are paid for by the trainees and therefore a sustained income entry will always exist.

As it has been expressed before (refer to chapter 2.4) it is very difficult to quantify at this stage the amount of trainees the ECHD will have, therefore, the costs of the individual trainings should be set after the pilot trainings. The reason for this is that it will be easier to assess the interest student in becoming future trainees and to estimate the number of students per course. Knowing the expenses per-course-given and the amount of students, the final course price can be set. Nevertheless, a estimated financial investment for the establishment of the center is given in chapter 3.6.
It is recommended that courses should not be larger than 15 students to maintain classes small which creates better and closer relationships between students and Instructors and which positively reflects on their learning.

Nevertheless, external funding could be requested for large investment activities such as purchasing equipment, adapting facilities and so on. Organizations such as GIZ and World Bank among others, could be approached by the President of the Division with specific investment plans seeking for such fundings.

Deliverables

-- Training Center

The main objective of the center is to work as a training center. According to previous experience, the works related to a SHP setup can be divided into different stages of a project's life. Each one is described and the main skills to be provided by the ECHD in that particular training are specified.

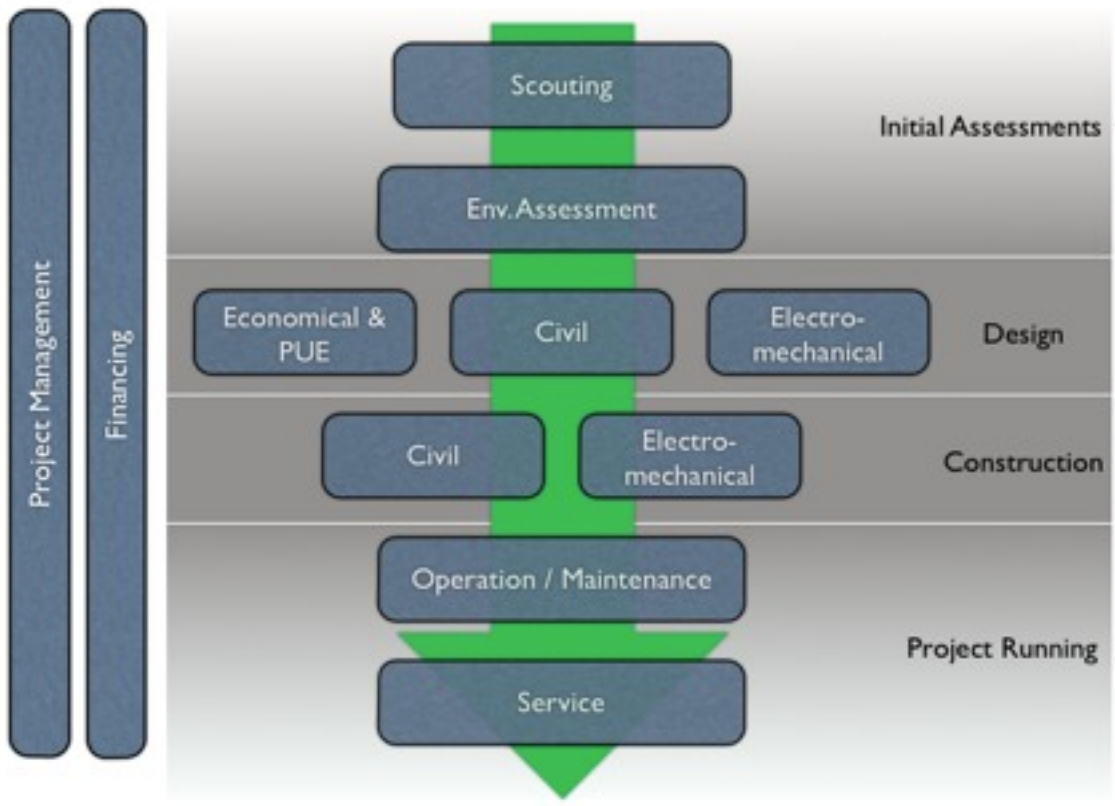

Fig 3.3 Stages on a SHP project development
(Source: Author own development)

In Fig 7.1, the different trainings suggested for each stage are shown including Project Management and Financing which are constituents of all steps of the project.

The courses were described and the main target audience based on Chimoio's education reality was identified. Also, using worldwide trainings, basic outlines are presented on the major topics to be covered.(Arba-Minch-University (#1) 2011; Arba-Minch-University (#2) 2011; Arba-Minch-University (#3) 2011; Arba-Minch-University (#4) 2011; Arba-Minch-University (#5) 2011; Arba-Minch-University (#6) 2011; Arba-Minch-University (#7) 2011; UNESCO-IHE 2012)

The list of courses is as complete as possible, nevertheless, new courses could be added as necessity dictates.

-- Knowledge Center

Building a Knowledge Center is of paramount importance for training future professionals, to spread lessons learned and to avoid starting all over again in each project. Based on that, the stakeholders requested that the ECHD should include it among its objectives.

The Knowledge Center should be built with contributions from all members of the Executive Committee and the External Advisory Board. Some of the materials are/ should include:

- Books
- Research papers
- Thesis papers
- Relevant legal information

Also it was highlighted the need of having a database with current and future projects. This database will provide as much information as possible from each setup, including when available up-to-date date of production.

A web page for the ECHD to share, particularly with trainees, the information acquired by the Knowledge Center, was also seen as an important goal.

-- Contact Center
Organizations, institutions, companies and private enterprises working on the field of HP in Manica are in general scattered and not strongly connected. The need of having a central authority that, would unite them all, was requested by the stakeholders. This is the task that the Contact Center will perform.

The Contact Center will identify all entities working in the HP sector in the province and maintain detailed information about their scope of work, objectives, projects done. This information can be provided to those who are seeking partners for new or ongoing projects and it will facilitate networking in between research institutions.

-- Research Center
Most Universities mentioned in many occasions that they lack proper facilities and means to do research.
The laboratories from the ECHD could eventually be used with this purposes. Research on HP subjects including new technologies or improvements on current ones could be tested by implementing new ideas and allowing students and teachers to get advanced degrees.

Even when this is an important objective for the Division, it may take several years to be accomplished as local professionals acquire the required HP field experience. Therefore the Research Center should not commence until a later stage.

-- Expert Consultancy
Organizations and Governmental agencies usually need to consult experts in HP related subjects to be able to run certain projects.

The Hydropower Division will position itself as the maximum authority in the field of HP in the province, therefore, with the passage of time, this task should be requested to

the ECHD. These advisory jobs should be another income generating activity to help sustain the Division.

Roles & Responsibilities

Defining the roles and responsibilities is one of the most important parts of the project.

To do so, as a first measurement, a structure was designed. It was requested that it should present with two characteristics, it should be simple and expandable. The requirement of simplicity was born due to the idea that complex structures tend to have more personnel that needed and that any decision process needs to pass by several layers of agreement, therefore it does not allow quick response and adaptation.

The characteristic of being expandable was expressed by the stakeholders as a need for future development into other technological fields. Nowdays the focus is the HP sector, but in the future, other technologies such as biomass or solar power could be pursued. For this reason, the model should be designed in such a way that can grow if required.

The suggested ECHD structure is presented here:

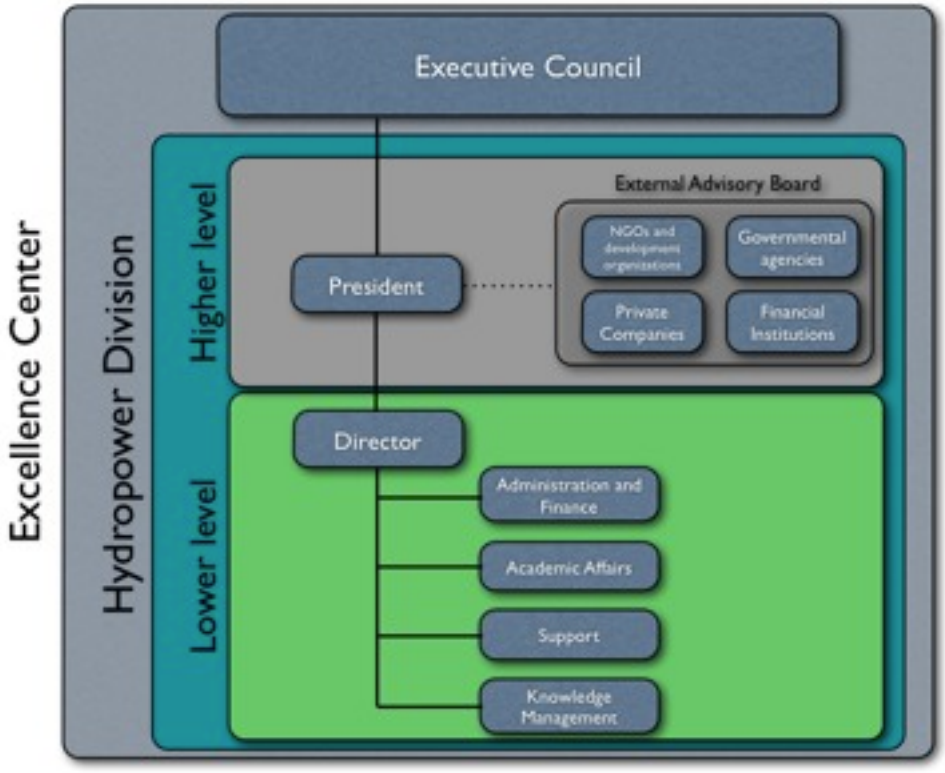

Fig 3.4 Initial Excellence Center structure with only an Hydropower Division
(Source: Author own development)

In Fig 3.4, the outer dark gray layer is the Excellence Center itself and it contains the Executive Council and the Hydropower Division. If new Divisions were added, the structure would change to this:

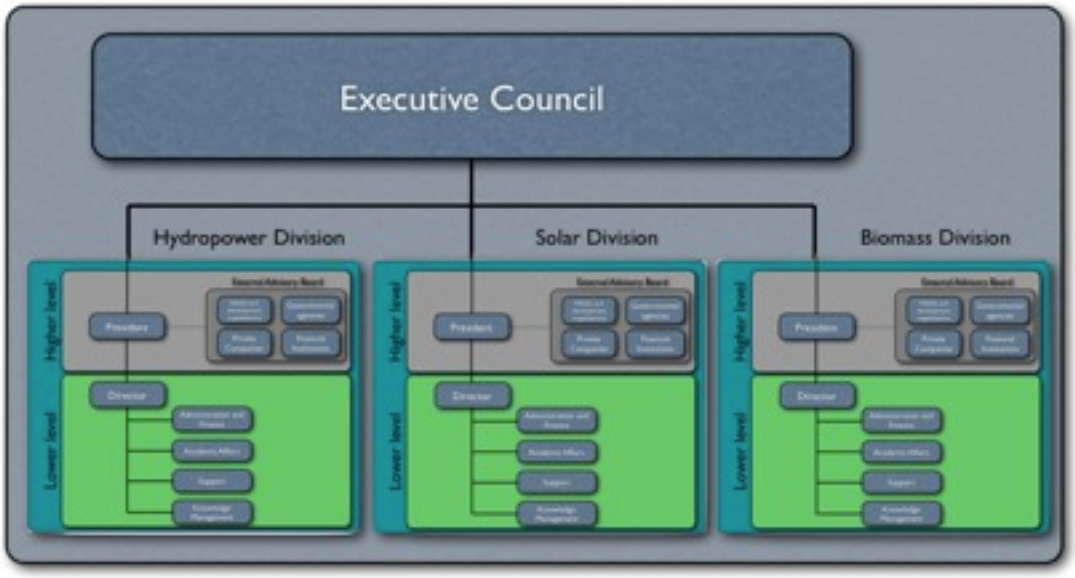

Fig 3.5 Excellence Center with Biomass,
Solar and Hydropower Divisions
(Source: Author own development)

The Executive Council will be in charge of deciding the future of the center. All members are equally important and have the right to give their opinion.
Is important to remark that the Executive Council contains a smaller unit called Superior Council for each Division.

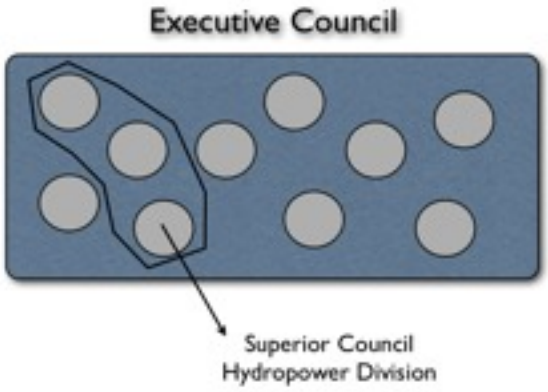

Fig 3.6 Executive Council and Superior Council
(Source: Author own development)

Each Division has assigned to it a Superior Council formed by a few members of the Executive Council. This groups represent the highest authority of that particular Division and it is composed of those Institutions who share more objectives with the ECHD. When discussing subjects that may affect the future of the Division, the SC should listen to all members of the ExC before taking a decision.

A President, who will be the head of the Division for an agreed period of time, is selected among the members of the Superior Council.
The role of the President is to represent the SC and to work closely with the External Advisory Board, looking for new partnerships and projects the Division could get involved with.
After the President's period is over, the role will be covered by another member of the SC based on a rotational scheme.

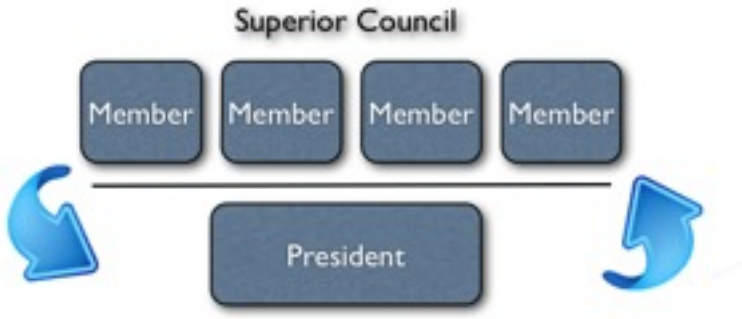

Fig 3.7 President position rotational scheme
(Source: Author own development)

This membership rotation has been used by the stakeholders successfully before in other endeavors. It allows on the one side the possibility for everyone to contribute to the future of the center from their own perspective, and on the other side avoids having a single institution taking control of the activities of the center.

The External Advisory Board is intended to be composed by all external Organizations, Institutions, Governmental agencies and private companies that are willing to collaborate with the Division.
Their responsibilities are to be discussed per case bases. The initial contact should start at or be addressed to the President of the Division and once the details of a possible cooperation are defined, the proposal should be taken to the Superior Council for analysis.

The Director and all the staff of the lower level structure should dedicate their time to the daily activities. They should oversee the basic organization, classes, material, equipment status, and so on.
The Director is responsible of reporting any major concern or unusual event to the President.

The particular position of the individual stakeholders in the given structure is suggested by using the results of the research in a document called 'Suggested Roles' (please refer to annex A4).

Implementation Plan

Please refer to chapter 8.

Monitoring and Evaluation

The addition of Monitoring and Evaluating strategies to the development of the project is of outmost importance as it will ensure quickly identification and solution of problems with minor impact.

One of the mechanisms implemented by the ECHD will be to identify all inputs and outputs of individual stages until the running phase. By comparing the results to the expected output, problems could be found and solved before moving on to the next stage.

It is also suggested to establish linkages with private companies that can help identify changes in market trends affecting the future of the Division.

Reporting

Reporting will play an essential role to keep the ECHD performing as expected. A series of reports with different scopes, authors and target audiences were suggested to maximize the amount of information collected, which would provide insights into the future steps the Division should pursue.

The list of suggested reports is:

Name	Reporter	Intended Audience	Frequency
Biannual Performance Report	President	Executive Council	6 months
Final Presidential Report	President	Executive Council	Once per period
Monthly Report	Director	President	Monthly

Table 3.5 Reports main information

This is by no means a comprehensive list and should be extended if needed.

Success Criteria

The success criteria represent some of the expected outcomes that the ECHD should achieve once it is fully functional.
These were obtained from different stakeholders' meetings where they envisioned what the ultimate goal should be under their perspective.

The criteria that the stakeholders expressed is listed underneath:

- At least 70% of students from the ECHD employed in works related to the field (existing companies, self-employment, organizations, etc)
- Higher electrification rate in rural areas due to projects done by the ECHD' graduates
- Higher community development through PUE from projects done by the ECHD' graduates

While the first one is very specific (given by GIZs' program coordinator), the second and third success criteria are qualitative and more difficult to commonly agree on their achievement (given by the universities representatives and a government official). The lack of a quantitative figure comes from the fact that is still unknown how many trainees will be taking courses and even further, how many of them will run successful projects. For this reasons, at the current stage of development of the center, it would be unrealistic to establish a more precise expectation.

3.5 Implementation Plan

This is one of the key elements of the project. The implementation plan needs to be done in such a way that it gives results as soon as possible but it should also make possible the early identification of potential problems that could endanger the future of the entire project.

The plan was divided in 3 phases and a total of 12 stages. The phases represent clearly distinctive moments during the setup of the ECHD. These phases are:

Preparation Phase: It is meant to prepare the ground, bring the idea of such a center to all stakeholders and create interest, which lead the first steps towards training future instructors. This phase is composed of 6 stages.
Start up Phase: During this phase, the Instructors will give their first pilot trainings to a selected group of student, closely monitoring the outcome. This will allow to identify any deviations from the expected results. This phase is composed of 2 stages.
Running Phase: Once possible problems from the start-up phase have been solved, the ECHD is ready to open its doors to the public. This is a continuous phase, in which monitoring and evaluation schemes will be used to control the outcomes of the courses. As the center gains experience, the Research Center and the Expert Consultancy activities could be considered ready to start. This phase is composed of 3 stages.

For every stage in the different phases, a clear set of Inputs and Outputs has been given. This will contribute to evaluate the performance of each stage and to identify the proper time for the next one to begin.

The following graph represents the expected execution time for the individual stages. The phases can be identified as follows: Preparation in red color, Start up in yellow color and Running in green color.

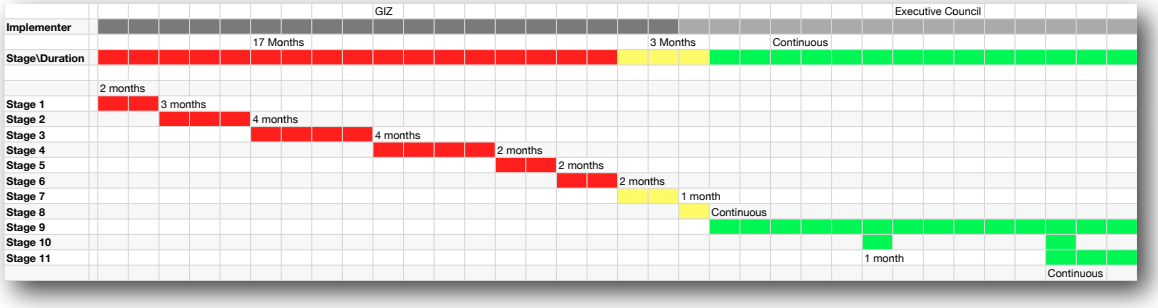

Fig 3.8 Expected execution timeframe

In the graph it can also be identified who is the implementer of each Stage is. GIZ will contribute managing the development of the project until the end of Stage 7. From Stage 8 on, the Executive Council will take over this role.

The amount of time for each stage comes from previous experiences and courses'. Also includes a safety factor in case there are unexpected delays.
Even when the expected duration of each stage is given, there is still no initial date because the beginning of Stage 1 is yet to be discussed with the Institutions of Higher Education.

The list of the individual stages and their main objective is described underneath.

Preparation Phase
Stage 1 - Commitment from universities, selection of teachers and MOU signing
Stage 2 - Project I (first practical experience in an HP project for teachers)
Stage 3 - Project II (second practical experience in an HP project for teachers)
Stage 4 - Project III (third practical experience in an HP project for teachers)
Stage 5 - Teachers trained to become Instructors
Stage 6 - Curricula design and equipment list preparation

Start up Phase
Stage 7 - Pilot Trainings
Stage 8 - First Executive Council meeting to review results

Running Phase
Stage 9 - Formal opening date of the ECHD
Stage 10 - Review meeting and Knowledge Center start
Stage 11 - Research and Consultancy activities start

In Stage 1 the Memorandum of Understanding or MOU will be signed by the main stakeholders so give a formal framework to the process. A first draft of this document was also prepared (please refer to Annex A5).

For further description on the stages refer to section 9 of the ToR (Annex A1).

3.6 Investment Analysis

As initially requested, it was performed a basic analysis of the Investment costs that the stakeholders would incur when preparing the ECHD to start.

The following are the three major items that were discussed as important costs during the setup of the center:

- Training of the Instructors
- Consultancy of experts
- Equipment

They can be analyzed individually to obtain a better perspective of the scope of such activity.

3.6.1 Training of the Instructors

As stated on Implementation Plan of the ToR, it is paramount that teachers are trained by experienced professionals to cover their own knowledge gaps. This may represent one of the major expenses the ECHD will face before it is established.

GIZ requested that the travel expenses should not be considered in this analysis.

The training in centers abroad cost:

IN-SHP(China): **0 €** - One course can be free for a person if it was previously arranged and coordinated to coincide with one of their government sponsored trainings. Prices for other courses were not given. They should be arranged under the specific needs of the trainees.

Kafue Gorge Training Center(Zambia): **1500 € to 3000 €** depending on the training

Arba Minch Center of Excellence(Ethiopia): Only one training price was available. The general SHP training costs **1400 €** .

Hydropower Competence Center(Indonesia): This center is designed to train instructors and was opened recently. There is no information regarding costs yet available, but they have shown interest in preparing tailored-training for our Instructors.

Bearing in mind that there are 11 courses to be given by the ECHD, the expected average budget (estimating 2000 € per course) of training the instructors will be close to **22000 €**

For a detailed description on the training centers abroad, please refer to Appendix A3

3.6.2 Expert Consultancy

During the process of curricula development, the contribution of experts with proven background on the area of education will be needed. The curricula will have to be written under the Mozambican normative to be, later on, approved by the Ministry of Education.
For this reason, it will be almost mandatory to bring such an expert into the project. The cost of hiring such a professional ranges, on daily basis, in between 500 € and 700 € for international experts and 250 € and 600 € for a local expert.

As one of the main objectives of this center is to boost the local capacity and as the knowledge is locally available, it is encouraged that the expert should be local.
Considering that each course curricula will need from 1 to 5 days of discussion (these numbers are the authors expectations due to the complexity of each training and the description of the curricula already given), we can make an estimation of the cost range for all courses:

Course	Expert [days]	Cost(high) [€]	Cost(low) [€]
Basics	2	1200	850
Site Surveying	3	1800	1275
Environmental Assessment	4	2400	1700
Design- Economical and PUE	5	3000	2125
Design- Civil	4	2400	1700
Design- Electro mechanical	4	2400	1700
Construction- Civil	3	1800	1275
Construction- Electro mechanical	2	1200	850
Operation / Maintenance	3	1800	1275
Service	2	1200	850
Financing	1	600	425
Project Management	5	3000	2125
Total	**38**	**22800**	**16150**

Table 3.6 Expert consultancy days per course

Universities could also use their personnel that in the past have performed similar tasks for their own courses. In this case, it could be agreed that, as it is for everyone's benefit, it should be done for free or charging a small fee to cover for the teachers' expenses only.

3.6.3 Equipment and material

Due to the fact that the list of equipment will be better prepared during Stage 6 and, since GIZ AMES-M has already prepared a basic projected investment for the ECHD (GIZ 2011), the author does not see the necessity to prepare a second list that will probably contain most of the same elements.
Therefore, until the equipment list is improved during the Stage 6, we will use the results of the previous report.

Category	Description	Quantity	Estimated cost [MZN]	Total [MZN]
1. Laboratory Equipment	Water flow measuring channels x 4 different types	4	5,000	20,000
	Turbine testing tables x 4 different types	4	10,000	40,000
	Pump testing tables x 4 different times	4	6,000	24,000
	Pressure measuring manometers and gauges	8	2,000	16,000
	Laboratory infrastructure	1	40,000	40,000
	Accessories and spares	1	15,000	15,000
2. Workshop Equipment	Smelting furnace, forge and casting moulds	1	5,000	5,000
	Lathe	1	4,000	4,000
	Milling machine	1	4,000	4,000
	Shaper	1	4,000	4,000
	Drilling machine	2	3,000	6,000
	Grinding machine	1	1,000	1,000
	Welding machines	2	1,000	2,000
	Hand tools like surface grinder, hand drills, spanners	5	500	2,500
	Work benches	12	500	6,000
	Accessories and spares	1	4,000	4,000
3. Field equipment	GPS	8	500	4,000
	Conductivity meters and current meters	4	1,000	4,000
	Damp levels, theodolites and total stations	4	800	3,200
	Altimeters, clinometers and sighting levels	8	200	1,600
	Vehicle 4x4 usage	1	60,000	60,000
	Accessories and spares	1	7,000	7,000
4. Office Equipment	Office furniture	4	1,500	6,000
	Computers – Desktop and Laptops	4	1,000	4,000
	Printers and Plotter	2	2,000	4,000
	Projectors	1	1,000	1,000
	Accessories and spares	1	2,000	2,000
5. Overhead, training fees, etc.		1	100,000	100,000
Total				**390,300**

Table 3.7 Basic equipment list
(Source: GIZ 2011)

The numbers are given in Meticais which is the local currency in Mozambique. Being the exchange rate: 1 € = 35.70 MZN in Feb 13, 2012 (XE 2012).

From here, the total amount would be: **10931.76 €** under the prepared investment plan.

Examined from the Stages point of view, we can estimate the amount of money that would be needed to run them as follows:

Preparation Phase
Stage 1 - Commitment from Universities and selection of teachers

- Field trips (2 trips for directors and teachers added together) **400 €**

- Meetings **100 €**

Stage 2 - Project I

- Project I Implementation
(These are overhead costs for project implementation and will be covered by GIZ)
These numbers are still being prepared by GIZ and no figure was available at the time of finishing this paper.

Stage 3 - Project II

- Project II Implementation
(These are overhead costs for project implementation and will be covered by GIZ)
These numbers are still being prepared by GIZ and no figure was available at the time of finishing this paper.

Stage 4 - Project III

- Project III Implementation
(These are overhead costs for project implementation and will be covered by GIZ)
These numbers are still being prepared by GIZ and no figure was available at the time of finishing this paper.

Stage 5 - Teachers trained to become Instructors

- Trainings cost (for all teachers not including traveling expenses) **22000 €**

Stage 6 - Curricula design and equipment list preparation

- Curricula Design **22800 €** to **16150 €**
- Equipment and material **10931.76 €**

Start up Phase

Stage 7 - Pilot Trainings

- Training basic expenses per course **200 €**

Stage 8 - First Executive Council meeting to review results

- Meeting **100 €**

Running Phase
Stage 9 - Formal opening date of the ECHD

- Opening Ceremony **500 €**

Stage 10 - Review meeting and Knowledge Center start

- Meeting **100 €**

Stage 11 - Research and Consultancy activities start

- Meeting **100 €**

This adds up to a total investment between **57232 €** and **50582 €**

This number represents the start-up costs, that is, the amount of money to be invested from now until the center is opened and ready to give courses.
The share of these expenses each stakeholder will bear is still to be discussed between the Universities and GIZ AMES-M.

The costs to be paid by trainees for the individual trainings cannot be calculated at this point because the amount of future students is unknown. It is expected that it will be much easier to obtain a realistic figure after Stage 7, because the mount of prospect students can be estimated by the amount of enrollments for the pilot trainings.

4. Conclusions

The availability of hydro resources and skilled human capital in a province such as Manica where most rural communities lack access to basic energy services, establish the bases for the success of a locally run Excellence Center with focus in Hydropower technology.

The Capacity Development approach followed by GIZ AMES-M has proven so far to be highly accepted from the local institutions, governmental agencies and private enterprises, all of whom have repeatedly showed their support and gratitude. Moreover, it has contributed to establish strong relationships with current and potential partners in the field. This was particularly noticeable in the meetings held for the ECHD.

The Excellence Center and its Hydropower Division will bring new options for students and professionals willing to upgrade their knowledge and to acquire practical skills highly valued by local companies. It will also expand the Universities network by connecting them with International partners on similar endeavors which will in turn facilitate the knowledge transfer from experienced professionals.

It is expected that, through the projects implemented by the ECHD future graduates, communities in and around the Manica province will have increased access not only to electrical energy for personal usage such as lighting and basic appliances, but also to a source of energy that can be used with economical objectives such as hair cutting, sawing, milling, and so on.

During the meetings with the Higher Education Institutions, it was evident their enthusiasm and willingness for the project to continue. This ensures that the ECHD will become a reality in the near future.

The Terms or Reference prepared through this research show how the involved stakeholders can work cooperatively to achieve their individual goals and, proposes a structure that allows the center to fulfill its current purposes without limiting future new horizons.

Finally, as designed, the ECHD will be independent from foreign projects and programs by being locally managed and financially self-sustained, boosting community development by using the most important resource Mozambique has to offer, its people.

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Institution: REN21
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Author: **GIZ**
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Title: **ACCESS TO MODERN ENERGY SERVICES In Mozambique**
City: Chimoio
Alternate Title: An overview and outcome of an approach by GIZ-AMES Mozambique

Annexes

A1 - ToR

Access to Modern Energy Services Mozambique - AMES-M

Terms of Reference

Chimoio's Excellence Center Hydropower Division

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Review

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Table of Contents

List of Acronyms

GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit (German International Cooperation)
EndDev	Dutch-German energy partnership Energizing Development
AMES-M	Access to Modern Energy Services program in Mozambique
FUNAE	Fundo Nacional de Energia(National Energy Fund)
UP	Universidade Pedagógica (Pedagogic University)
UCM	Universidade Católica de Moçambique (Catholic University of Mozambique)
ISPM	Instituto Superior Politecnico de Manica (Higher Polytechnic Institute of Manica)
UniZambeze	Universidade Zambeze (Zambeze University)
ESEG	School of Higher Education for Economy and Management
AKSM	Associação Kuaedza Simucai Manica (Kuaedza Simucai Manica Association)
RE	Renewable Energy
HP	Hydropower
HPP	Hydropower Plant
MHP	Micro Hydropower
SHP	Small Hydropower
PUE	Productive Use of Energy
NPV	Net Present Value
IRR	Internal Rate of Return
MOU	Memorandum of Understanding
ECHD	Excellence Center - Hydropower Division
EC	Excellence Center
ExC	Executive Council
SC	Superior Council
EAB	External Advisory Board
GWh	Gigawatt hour(s)
MW	Megawatt(s)
kW	Kilowatt(s)
kWh	Kilowatt hour(s)
W	Watt(s)

1. Introduction

The present paper represents the Terms of Reference (ToR) for Chimoio's Excellence Center - Hydropower Division. It is the outcome of the joint coordinated work of several Institutions and Organizations trying to balance their interests to obtain the most beneficial outcome for the community and all participants.

2. Purpose

The Excellence Center - Hydropower Division is meant to cover the gap existing between current new university graduates and young professionals and the hands-on expertise the market needs in the field of Small Hydropower.
The main objective is to provide practical training in all the stages of a SHP project, as well as to function as a knowledge and contact point for all companies, professionals, organizations and governmental agencies that work in this particular field.

3. Initiated by

This project was initiated by GIZ AMES-Mozambique in association with Universidade Pedagógica, Universidade Católica de Moçambique, Instituto Superior Politécnico de Manica and Universidade Zambeze.

4. Background

4.1 Context

Studies done by the World Bank in 2007 have shown that the potential for hydropower generation in Mozambique is substantial. About 13000 [MW], producing 65000 [GWh/y] of energy, can be economically developed in Mozambique. About 70% of this potential (10000 [MW], 45000 [GWh/y]) is concentrated in the Zambezi watershed, most of it on the Zambezi river which include the provinces of Manica, Niassa, Zambezia and Tete. From which 1000 [MW] belong to the Mini, Micro and Pico generation schemes.

Aware of this, from the year 2000 forwards, the Mozambican Government has been giving increasing support to the development of energy options for rural areas and to the role that renewable energies should play in the country's energy matrix through new policies and projects done by its agencies.

This, along with the availability of Higher Education Institutions that strive to develop their students in the fields the country need, resulted in a coordinated effort to bring together knowledge and experience in the SHP field to form the Hydropower Division of the Excellence Center in Chimoio.

4.2 ToR

The objective of this ToR is to formally prepare the grounds for the ECHD and to have a defined and structured start that allow the participants to measure and monitor the outcome of every stage.

The objective of the deliverables in this document are to cover the gap between the knowledge of graduating students and professionals and what the market needs to develop SHP projects.

4.3 Excellence Center

The Excellence Center's objective is to cover different technological areas that, being lead by Higher Education Institutions, can bring development through sustainable energy generation and productive uses of that energy to Chimoio, the surrounding communities and Mozambique.

Chimoio's Excellence Center will start with the Hydropower Division. And even when initially it will only include that one, future divisions may be form to tackle new technological fields.

5. Objectives

The following are the main objectives of the Hydropower Division of Chimoio's Excellence Center:

- To provide training to current and future professionals in every stage of a SHP project
- To serve as a Knowledge Center
- To serve as a Contact Point
- To serve as a Research Center
- To give expert consultancy

6. Scope

6.1 Language

The chosen language for the courses in the ECHD is Portuguese. Possibly, counting on the addition of courses in English in the future.

6.2 Geographical Market

The geographical market will be tackled in stages, the following are the proposed steps:

- Chimoio City
- Manica Province
- Mozambique
- Regional

This will allow the ECHD to grow as the stakeholders and participants become more confident and experienced.

6.3 Project sizes

Chimoio's ECHD will focus its deliverables in SHP endeavors (<15 [MW]). With particular interest in Micro and Pico setups (according to Practical Action <100 [kW] and <5 [kW] respectively).

6.4 Physical location

The ECHD will not have its own physical location during the first years of existence. Therefore, classrooms, conference rooms, laboratories and so on needed during that time will be provided by the members of the Executive Council, preferably by the members of the Superior Council.
The provider of the location can decide to charge a symbolic fee for the usage, to be used to maintain the facilities and/or equipments.
In the case of using a room as a laboratory in which the equipment is provided by the ECHD, a contract should be prepared between the provider of the physical location and the Center to clearly detail expenses to be paid and the legal responsibilities of both parties.

6.5 Finance

Even when external funding could be requested to purchase equipment, adapt facilities or similar high cost activities, the ECHD needs to be self sufficient in financial terms. This means that in principle it should not depend on any external donors for their day-to-day activities.

The main income generating activity of the Division will be the training courses. Expert consultancy for private companies, governmental agencies and other external entities will also contribute to generate income but this activity will start in a later stage.

7. Deliverables

7.1 Training Center

The main objective of the project is to work as a Training Center. Previous experience have shown that works related to a SHP setup can be divided into different stages. Those stages required specific trainings that will be provided by the ECHD and which are described below.
The *Basics* training will be included in all of the courses and which will create a common ground knowledge, bring safety awareness and establish a unified vocabulary between the people working in this field.
All courses should be supported by regular visits to projects in progress so that students can have a in-the-field picture of what they see in classrooms and laboratories.
Also a "Lessons learned" should be added to each course to share with trainees common failures or solutions found in real life experiences in local projects.
These only represent the first set of courses the ECHD will offer and they may be increased to include other options if it is found that is necessary.

Basics

Description: The basics training will introduce a base knowledge and safety awareness for everyone working in the HP field.
Main target audience: All participants should go through this training.

- Hydropower Basics
- Safety concerns in the workplace

- Water & Environment

Site Surveying

Description: This course will prepare the future scouts giving them general knowledge about HP setups, how to recognize potential sites, measure flow and head, calculate estimated outputs and identify possible issues with the location and how to solve them.
Main target audience: Students with knowledge of physics, mathematics, and/or environmental science would be the main audience.

- Site recognition
- Flow determination methods
- Head measurement methods
- Power calculation basics
- Civil works basics
- Turbine overview
- Power utilization
- Environment protection
- The role of the surveyor (scout)
- Lessons learned

Environmental Assessment

Description: This course will aim to assist the trainee in identifying the potential environmental effects that a HP setup could cause and how to address them.
Main target audience: Students with knowledge in environmental and/or natural sciences would be the main target.

There are already courses given by the Universities on Environmental Assessment, the ECHD will complement them by providing specific environmental assessment technics and tools used on SHP projects.

- Environmental concerns with SHP
- Community assessment
- Lessons learned

Project Design & Development
- Economical and Productive Use of Energy

Description: This course has as objective to teach the trainee how to prepare an economical assessment using standard analysis technics which will allow to obtain a clear picture if the project is feasible under an economical perspective.
Main target audience: Students or entrepreneurs with knowledge in economy, finance and/or business.

- Financial terminology and basics of business planning
- Methods for estimating costs and revenues of the project
- Cost estimation: preliminary work, construction of the site, transmission and distribution network and costs of labor needed
- Revenue estimation

- Cash-flow calculation based on costs and revenues
- Writing the Economical part of the Business Plan (including calculation of NPV, DSCR (Debt Service Cover Ratio) and potential loan maturity)
- Critical assessment of "bankability" of business plan
- Local commercial banks, terms and conditions for working with them
- Lessons learned

- Civil

Description: This course has as objective to train people in the specific civil works related to HP setups, how to design and how to manage the construction.
Main target audience: Students with knowledge in civil construction.

- Civil components of a MHP
- Cofferdam design
- Weir design
- Intake design
- Channels design
- Settling Basin design
- Forebay design
- Support Structures design
- PowerHouse/Tailrace design
- Lessons learned

- Electro-Mechanical

Description: This course has as objective to train people in the specific electro-mechanical design and equipment selection related to HP setups and how to manage the installation.
Main target audience: Students with knowledge in electricity, electronics, mechanics and/or electro-mechanics.

- Generator selection and sizing
- Control system
- Load analysis
- Power distribution system
- Protection and earthing
- Turbines basics (Pelton, Cross flow and Pump as turbine)
- Turbine selection
- Mechanical power transmission
- Lessons learned

Construction

- Civil

Description: This course is aimed to train people working in the construction field on how to use particular techniques or special local materials.
Main target audience: Constructors, bricklayers, masons, stonecutters.

- Usage of local materials
- Local techniques for construction
- Lessons learned

- Electro-Mechanical

Description: This course is aimed to train people working in electrical and mechanical setups on how to use particular techniques, special local tools and correct methods of installation.
Main target audience: Electricians, mechanics**.**

- Turbine installation
- Generator installation
- Mechanical transmission connection
- Wiring
- Lessons learned

Operation/Maintenance

Description: This course is aimed to train people working as operators of the setups on how to perform their tasks correctly and how to do proper maintenance on the equipment.
Main target audience: Operators and entrepreneurs.

- Civil works maintenance
- Mechanical equipment maintenance
- Electrical equipment maintenance
- PUE equipment maintenance
- SHPP / PUE equipment operation

Service

Description: This training is meant to provide the correct servicing techniques for the different equipments used in a HP setup.
Main target audience: Employees from the equipment providers, electricians and entrepreneurs.

- Turbine service/fixing
- Generator service/fixing
- Electrical connections service/fixing
- Electrical distribution service/fixing
- PUE equipment service/fixing
- Civil works service/fixing

Financing

Description: This training is meant to provide knowledge to local bank on how to develop loans and financial options to HP projects.
Main target audience: Local banks and financial institutions.

The financial training will be different to the others. This training will be given by financial entities to bank or similar institutions to show them the possible benefit of providing financing options for small projects such as micro/pico HP setups.

Project Management

Description: This course has as objective to prepare trainees to run complete projects from the management side. It will allow them to do time, people and budget management and to be able to deliver projects as expected.
Main target audience: Entrepreneurs and students with management, coordination and/or economical knowledge.

- The project cycle and organization
- The critical factors, time and activity planning
- Managing the human resources
- Project financing and budgeting basics
- Writing the Business Plan
- Project accounting and financial reporting, control and monitoring
- The use of appropriate computer software

7.2 Knowledge Center

It is important that the ECHD maintains literature related to HP, this includes:

- Books
- Research related information
- Thesis papers
- Relevant legal information

There will also be a database with information of previously done, current and future projects with all the relevant information for future analysis and research. This database will include (when possible) information related to production in daily/monthly bases.
As the database grows, a webpage will be prepared to make the information available to a larger audience promoting free flow of information and contribution worldwide.

7.3 Contact Center

The ECHD will also provide a unique contact point to organizations, institutions, companies, private personnel on the area of SHP.

The ECHD will also bring together Education Institutions willing to work in coordination in the SHP field.

For this purpose, a database, which will be publicly available, will be created maintaining information about all players in this particular industry.

7.4 Research Center

The ECHD will provide the means and resources for advance research on improved or new techniques and technologies related to SHP.

Research will commence only after the Hydropower Division has gathered enough experience.

7.5 Expert Consultancy

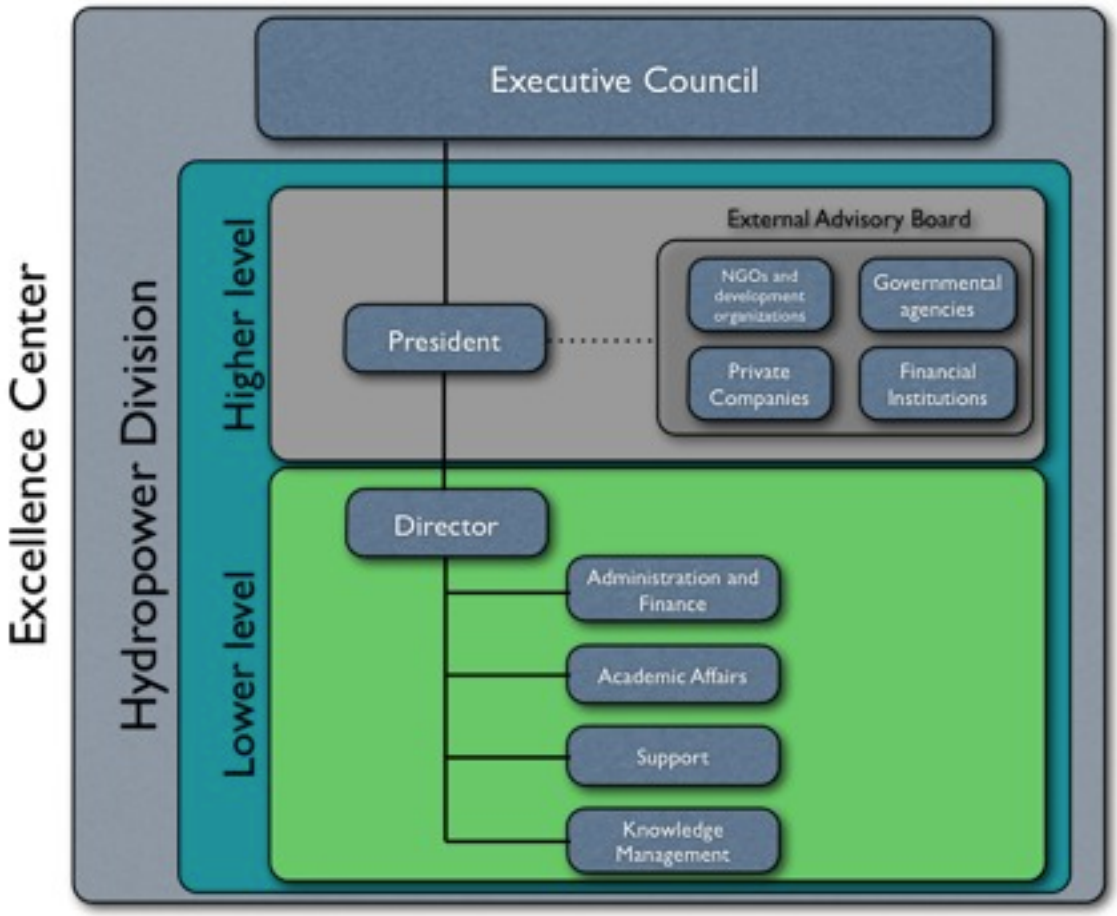
As the highest authority in the field of SHP, the ECHD will provide consultancy to Government agencies and organizations under request.
The expert consultancy activities will be performed only when the Hydropower Division has formed experienced professionals capable of performing such tasks.
This activities will impact directly on the viability of the Center as it is of vital importance to have income generating activities.

8. Roles & Responsibilities

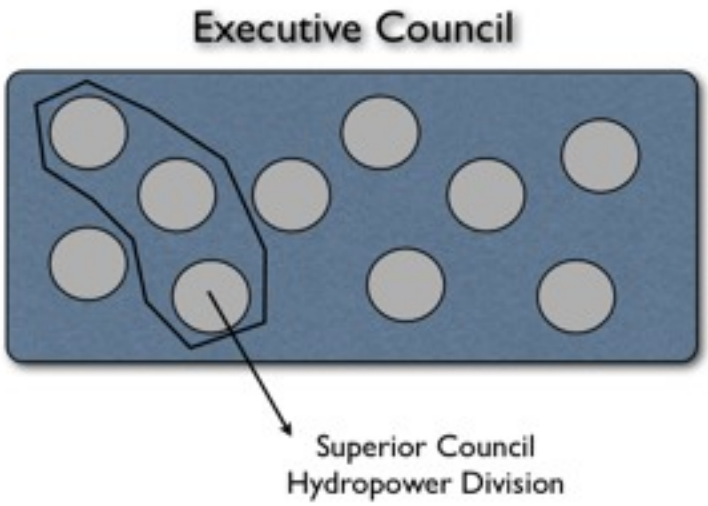
8.1 Structure

To define which the roles will be, a structure should be created to establish how the ECHD will operate.

The following represents the proposed initial structure of the Excellence Center - Hydropower Division. Not only it states a simple structure but it also allows growth and change when needed.



Where the Executive Council is divided as follows



8.2 Roles and Responsibilities

Executive Council
The Executive Council is composed of all the Higher Education Institutions. Every member has the right to give their opinion about any subject discussed, nevertheless, the final decision is made by the Superior Council of the Hydropower Division.
Their responsibilities are:
- To review reports from the President and make suggestions
- To bring ideas or suggestions into the table
- To hold a meeting every 6 months to discuss the performance of the ECHD

Superior Council HP Division
The Superior Council of the Hydropower Division is the maximum authority of that Division in the Center. This selected group is part of the Executive Council but due to their current or future plans in the field of HP they are selected to lead the Division.
From among the members one is selected to become President of the Division and represent the interest of all the SC members for one period.
Their responsibilities are:
- To analyze changes in direction
- To decide on modifications that affect the long term performance. e.g. new labs, accepting loans, etc
- To review reports from the President identifying trends or potential problems and making changes when needed
- To listen to every member of the Executive Council before making a decision

New members can enter this group if their future plans and objectives are such that the ECHD becomes an invaluable element for achieving them. A meeting should be held by the Superior Council to analyze the new member's inclusion.
The same way, a member can be asked to leave the Superior Council if it is decided that its future objectives do not contemplate the ECHD as a key element.

There can never be less than 2 members in the Superior Council.

Higher Level Structure

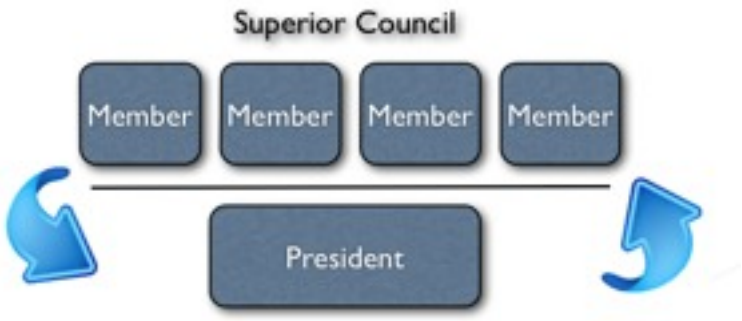
The higher level structure is divided into the President and the External Advisory Board. This structure is to remain unchanged for long periods of time.
Its members are concerned with the long term activity of the ECHD.

President

The President, who leads the ECHD, is the authority representing the Superior Council that leads the the ECHD. His responsibilities are:

- To lead the Division to achieve its goals
- To represent the ECHD in official events
- To hire and or replace personnel when needed
- To propose changes in facilities, courses, equipment, objectives and any other long term relevant aspect to the Executive Council
- To search for new members for the External Advisory Board
- To interact with the External Advisory Board to search for Financing, beneficial Partnerships, and so on
- To report existing or potential problems to the Executive Council
- To deliver the biannual and final reports

The President's role is taken by a member of the Superior Council in the particular Division. This position rotates every 3 years among the members.



External Advisory Board

The External Advisory Board is composed of all other Organizations, Companies, Governmental Agencies that are not Higher Education Institutions and hence not part of the Executive Council.
Providing these external players with the possibility to participate will allow the ECHD to make use of the knowledge, experience, financing, etc. available locally. The responsibilities for this group will be agreed upon in per case bases.

Lower Level Structure

The lower level structure is composed by the personnel in charge of supervising the daily activities . This structure will be subject to change as the ECHD develops and grows.

Director

The director is the highest Division authority in daily activities. Its responsibilities are:

- To ensure the courses run smoothly
- To report important problems to the President

- To make suggestions for improvement to the President
- To prepare the monthly report on the Division's performance

Administration and Finance
It is in charge of managing the ECHD under the Director's guidance and to oversee the financial aspects of the Division in every day activities.

Academic Affairs
It is in charge of working hand in hand with the instructors during the courses, to solve any problems and to give feedback of their outcome to the director

Knowledge Management
This group is in charge of collecting information, literature, contacts, etc. and preparing and maintaining the required media support for students, professors and external parties to access that information.
Indue time this group will be in charge of the Knowledge Center and Contact point activities.

Support
In charge of any support tasks needed, such as equipment maintenance, cleaning, repairing, etc.

9. Implementation Plan

The following is the roadmap for the ECHD to be implemented. Its main objective is to start small with a single project, trying to involve the key people, and grow slowly by evaluating every stage in such a way that, if trends or problems appear, they can be identified and tackled as soon as possible. GIZ will play a very important coordinating role in the initial stages, but from stage 8 onwards, it will transfer that responsibility to the Executive Council, who will be in charge of the ECHD from that point on.

These are the three different phases of the implementation plan

- Stages 1 to 6 belong to the preparation phase
- Stages 7 to 8 belong to the startup phase
- Stages 9 and 11 belong to the running phase

The expected time of execution for the project is given in section 9.12.

9.1 Stage 1

The first step will be getting Universities and teachers more involved, by showing them the outcomes that can be achieved through applying the technology in rural areas. In order to do that, visits to projects that GIZ AMES-M has done in the past and that are currently operating, will be organized for the heads of the Higher Education Institutions.
A MOU will be signed at this stage to show the commitment of the participating entities

With the authorities more involved, teachers (potential instructors) will be brought on board, to do so, presentations will be done by GIZ with the objectives of the ECHD and then visits will be programmed to rural communities to show which are the results of the projects that have been developed so far. The main objective of this stage is that they realize that the field is very promising and that they can become Instructors of the ECHD if they wished to be so.

Teachers play the most important role in the success of the Division, there for, a few rules are described here.

Requisites:

- Instructors should be energetic and enthusiastic people
- Their subject of study, in their respective Universities, should be related to what is expected of them in the ECHD
- They should have similar/shared goals to those of the Division
- Willingness to travel to training centers abroad and/or to rural areas for periods lasting up to a month

Incentives:

- Higher economical benefits
- Status
- Broader theoretical and practical knowledge on their subjects
- Better future job perspectives

Given that the different subjects require different sets of skills the following indicates which teachers would be hired, as well as, the importance of having them on-board since the beginning.

Subject	Importance (Low) 1 ..... 5 (High)
Scouting	4
Env. Assessment	2
Civil related subjects	5
Electro-Mechanical related subjects	5
Economical & PUE related subjects	5
Project Management	5
Operation/Maintenance/ Service	3
Financial	No instructor needed

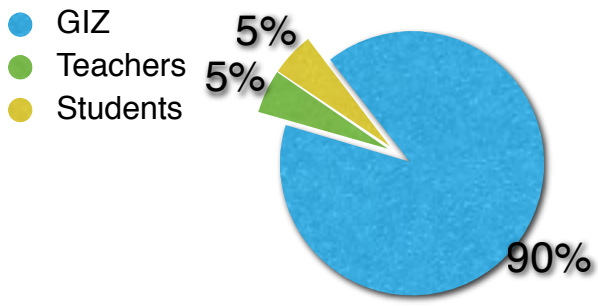
This means that from the beginning, at least 4 teachers should be selected to start their preparation.

Input	Output
All Directors	Higher commitment from the Institutions
7 Teachers	At least 4 Teachers interested in becoming instructors
	MOU signed

9.2 Stage 2

Stage 2 will imply involving both, teachers and students, in every step of the planning and implementation of a SHP project run by GIZ.
90% of the project will be implemented by GIZ, while students and teachers learn the procedures and techniques used. They will be given low complexity tasks, but it will be mandatory that all of the participants spend large amounts of time collaborating in the field.

Players:
- GIZ
- Teachers
- Students



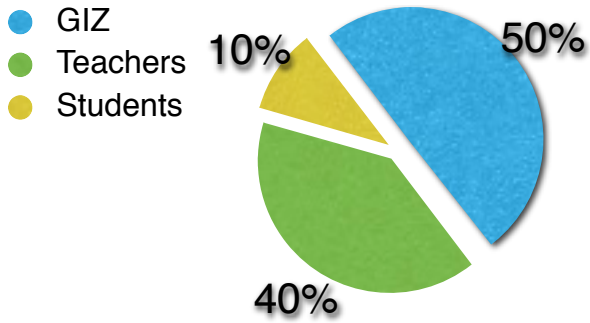
Input	Output
4-7 Teachers with little or no practical experience	At least 4 Teachers capable of doing and supervising basic SHP tasks
3 inexperienced Students	3 students capable of performing basic tasks related to SHP

9.3 Stage 3

In this third stage, more power and responsibility will be given to teachers, since it is quite relevant for them to acquire experience that they face problems and solve them by themselves.
GIZ will run 50% of the project and teachers will do the other 50%. Division of tasks will be discussed between GIZ and teachers and every player will be accountable for a part of the project. Students from Stage 2 and new students will be invited to join and collaborate with the project, thus increasing the task force and the hands-on experience of the participants. Teachers will be

responsible for assigning tasks to students. The higher the student's experience, the higher responsibilities that can be assigned to them.
GIZ will work also as a general supervisor to ensure the correct development of the project and that the objectives are met.

Players:
- GIZ
- Teachers
- Students
- Students from Stage 2

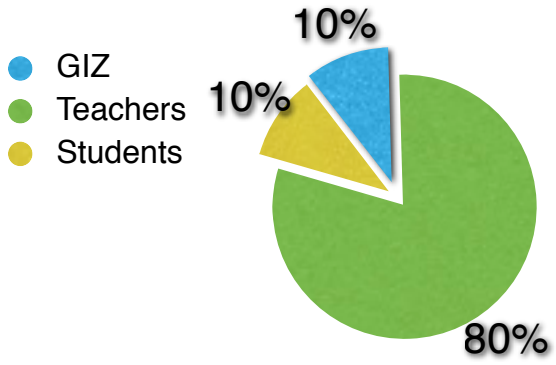


Input	Output
4 or more Teachers capable of doing and supervising basic SHP tasks	At least 4 Teachers capable of doing and supervising most tasks in a SHP project
3 students capable of performing basic tasks related to SHP	3 students capable of performing most tasks related to SHP with little supervision
3 inexperienced Students	3 students capable of performing basic tasks related to SHP

9.4 Stage 4

In this forth stage, teachers will take the leading role and run the project by themselves. Tasks will be assigned to the teachers according to their fields and they will be accountable for its outcome.
Students from stage 2, 3 and new students will be asked to join to increase the task force and collaborate with the teachers in the achievement of their goals. The higher the experience of the student, the higher the responsibilities that can be assigned to them.
GIZ will work as a general supervisor to ensure the project is finished in time and with the complete satisfaction of the customer.

Players:
- GIZ
- Teachers
- Students
- Students from Stage 2
- Students from Stage 3



Input	Output
At least 4 Teachers capable of doing and supervising most tasks in a SHP project	At least 4 Teachers capable of doing and supervising all tasks in a SHP project with no supervision
3 students capable of performing most tasks related to SHP with little supervision	3 students capable of performing all tasks related to SHP with little supervision
3 students capable of performing basic tasks related to SHP	3 students capable of performing most tasks related to SHP with little supervision
3 inexperienced Students	3 students capable of performing basic tasks related to SHP

9.5 Stage 5

At this point, teachers will have had a fair share of exposure to the tasks involved in a real project in the HP field. To become Instructors they should be properly trained, therefore, at this stage, they will receive the accurate training in their particular areas. This will give them all the specific knowledge that can only be shared by experienced professionals or learned after several years in the field.
Trainings could take place in Chimoio with personnel from GIZ, AKSM, Practical Action, FUNAE, and/or others, or abroad in other Centers depending on the specific training needs. This trainings will be organized by and paid for GIZ AMES-M.

It is very important to establish a contractual obligation in between the ECHD and the teachers before they are trained. This contract, which should last for 5 years, will specify the rights and obligations of both parties.
This will allow the organization to recover the training investment done on the teacher through the courses he or she will give and also search for a replacement. It will also allow the instructor to change fields or search for a better employment offer after the period has finished.
It is an obligation from both sides to remind each other, 1 year before the contract finishes, what their intentions are. The contract could be extended if both parties so agree.

Input	Output
At least 4 Teachers capable of doing and supervising all tasks in a SHP project with no supervision	At least 4 Instructors with experience on the field capable training both technical and practical courses.

9.6 Stage 6

Once the Instructors have received the trainings, the following things should be prepared in coordination with them:

- A list elaboration of the equipment needed to perform their particular trainings
- The curricula for the different courses should be reviewed in coordination with an expert of GIZ

After having participated in projects in the field and having been trained by professionals, the Instructors will be perfectly prepared to advice what kind of tools, equipments and instruments will be required during their trainings. At least part of this equipment list will be bought by GIZ.
Also, as they teach related subjects at the Universities their experience will also allow them to identify what are the weak subjects and which areas should cover in more depth with the courses.

Input	Output
At least 4 Instructors capable of training both technical and practical courses.	Equipment needed for trainings
GIZ experts	Curricula for the courses
	Detailed Investment Plan

9.7 Stage 7

At this stage Instructors should be ready to give their first pilot trainings in their particular field. A set of students with inclinations for the HP field should be selected among the Universities and then the first trainings should be give to them with the contribution and participation of students from Stages 2-4.
The outcome of this trainings needs to be documented, interviews with the trainees should be held to identify discrepancies from expectations and actual achievements and discover any potential problems that may have taken place during the courses.

Input	Output
At least 4 Instructors capable of training both technical and practical courses.	At least 4 completed courses
20 high achieving students with interest on SHP	At least 15 students ready to start working in SHP projects in their particular area

9.8 Stage 8

The first formal meetings of the Executive Council (ExC) should take place to discuss the following items:

- To review the outcome of the trainings
- To sign a formal agreement bringing the Universities together for the development of the ECHD
- To establish the Lower Structure of the EC
- To hire personnel
- To establish physical locations and course's schedule
- To launch a marketing campaign to promote the courses

This is one of the most important steps in the implementation process, it is here that the Higher Education Institutions take over the direction of the ECHD. Up to this point, GIZ will play a guiding role as one of the Excellence Center initiators, but from this point on, it will step aside and continue under its new role as External Advisory Board member.
Every member of the Executive Committee will assume their new responsibilities to ensure the success of the entire project.

Input	Output
Experience of the courses completed	Courses and Schedules
Detailed experience of 20 students that took the pilot course	Personnel hired for the lower level structure
Experience of the Instructors during the courses	Facilities selected
	Changes to the courses or other documents if needed
	Formal agreement between the Higher Education Institutions

9.9 Stage 9

Formal opening of the Center. Advertisement should be done to awake the interest of potential trainees.
The monitoring schemes should be applied to evaluate the performance of the courses and the way graduates develop in the field.

Input	Output
Documents from stage 8	Center opened
	Increased knowledge and interest from the public.
	Courses start

9.10 Stage 10

From this point on, scheduled meetings should be held every 6 months / 1 year by the ExC to evaluate the outcome of the trainings, the current employment of graduates, trends and issues that can be identified and corrected.
The building the Knowledge Center and the collection of contact information should start.
Also, markets should be analyzed to identify potential new areas that could be developed. Also as experience is obtained, it should be considered the expansion of the geographical market to include other areas, inside the country and abroad.

Input	Output
Courses output	New technologies to explore
Employment status from graduates	New geographical markets to embrace
Market trends from companies, governmental agencies and other institutions	Direction changes or courses adaptation to changes in the markets
Experience gained	

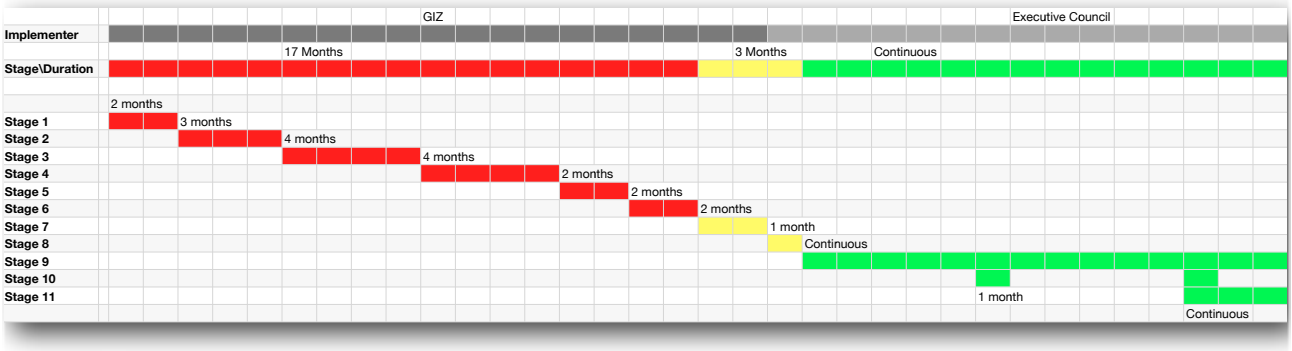
9.11 Stage 11

As the Hydropower Division gains experience and expertise, both the Research Center and the Expert consultancy activities should be scheduled to start.

Input	Output
Experience	Research activities
Expertise	Consultancy

9.12 Expected execution time

The following table represents the expected time consumption of the described stages and the sequence they should follow.



Stage 1: *2 months* to coordinate the meetings and have the presentations done
Stage 2: *3 months* to run the first project
Stage 3: *4 months* to run the second project
Stage 4: *4 months* to run the third project
Stage 5: *1 to 2 months* of external training
Stage 6: *2 months* for getting the equipment as well as for developing the curricula
Stage 7: *2 months* for pilot training
Stage 8: *2 weeks* to 1 month to evaluate the outcome and prepare for opening the ECHD
Stage 9: Opening the center and running it is a *continuous* activity
Stage 10: Should take place at least 6 months after the official opening and every other similar period of time. And it should take between *2 weeks and a month*
Stage 11: Should happen at last 1 year after the official opening time and is also a *continuous* activity

10. Monitoring and Evaluation

Monitoring will be done from the first stages so as to evaluate the correct development of the Division as its establishment takes place. As clear objectives have been defined for every step of the process the evaluation process becomes simple. The following indicates what should be the expected outcome of the individual stages:

Stage 1
- Higher commitment from the Institutions
- At least 3 Teachers interested in becoming instructors
- MOU signed

Stage 2
- At least 3 Teachers capable of doing and supervising basic SHP tasks
- 3 students capable of performing basic tasks related to SHP

Stage 3
- At least 3 Teachers capable of doing and supervising most tasks in a SHP project
- 3 students capable of performing most tasks related to SHP with little supervision

- 3 students capable of performing basic tasks related to SHP

Stage 4

- At least 3 Teachers capable of doing and supervising all tasks in a SHP project with no supervision
- 3 students capable of performing all tasks related to SHP with little supervision
- 3 students capable of performing most tasks related to SHP with little supervision
- 3 students capable of performing basic tasks related to SHP

Stage 5

- At least 3 Instructors with experience on the field capable of training both technical and practical courses.

Stage 6

- List of equipment needed for trainings
- Curricula for the courses
- Detailed Investment Plan

Stage 7

- At least 3 completed courses
- At least 15 students ready to start working in SHP projects in their particular area

Stage 8

- Courses and Schedules
- Personnel hired for the lower level structure
- Facilities selected
- Changes in the courses or other documents if needed
- Formal agreement between the Higher Education Institutions

Stage 9

- Center opened
- Increased knowledge and interest from the public.
- Courses start

Stage 10

- New technologies to explore
- New geographical markets to embrace
- Direction changes or courses adaptations to changes in the markets

Stage 11

- Research Activities
- Consultancy Activities

Also, a set of monitoring and evaluation mechanisms will be in place to observe the market and its trends to control the performance of the ECHD and the members that are in charge of running it.

- Information of every student should be available to identify their development after taking the courses

- Connections with local entrepreneurs in the field should be establish to observe the trends on different technologies
- Communities should be questioned about their needs and their experience with recent/past HP projects
- Objectives set vs accomplished for each President and Director should be reviewed at least yearly

11. Reporting

The following reports should be prepared by the members of the ECHD:

Biannual Performance report

Reporter: President
Audience: Executive Council
Frequency: every 6 months

This report will show the academical, economical and social performance of the Division to the Executive Council. It will include information such as:

- Detailed expenses
- Courses given (number of graduates, money collected, etc)
- Notes on important changes to the ECHD (people hired, big repairs/modifications, new partnerships, etc)
- Market trends of possible business that the Division could join

Final Presidential report

Reporter: President
Audience: Executive Council
Frequency: once, by the end of the period

It will include all the information of the Biannual Performance report plus a detailed historical evolution of that period. It should include information such as:

- Financial status (current and historical)
- Details of the courses given throughout the period (students, locations used, etc)
- Main partnerships and their contribution to the Division
- Goals achieved and detailed reasons for the objectives not achieved
- Challenges for the future President
- A follow up on the graduates to evaluate their current employment
- Market trends identified during the term which allow the possibility to solve them if negative or to embrace them if positive

Monthly report

Reporter: Director
Audience: President

Frequency: every month

This report is to be prepared by the Director on monthly bases and delivered to the President. It should present all the details about the Hydropower Division's performance throughout the (month, describing as well, any anomalies or unusual events and how they were or will be solved.

12. Success Criteria

Some success criteria can be identified, the most important being:

- At least 70% of students from the ECHD employed in works related to the field (existing companies, self-employment, organizations, etc)
- Higher electrification rate in rural areas due to projects done by the ECHD' graduates
- Higher community development through PUE from projects done by the ECHD' graduates

A2 - Stakeholders description

Universidade Pedagógica

Type of Actor: Higher Education Institution

Level of linkage to the EC: HIGH

Role(s)
Superior Council - Hydropower Division
President - Hydropower Division

Description

The UP is a public university in Mozambique which has as it's main mission to train teachers and higher level education frames, providing them with instruments both scientific and pedagogical-didactic enabling them to deliver a high-quality education in the education sector.
With a total of over 35000 students,from which 520 correspond to the Province of Manica(UP 2009), is one of the biggest and more important Universities in the country.

Interface with the EC

- Proposed contribution
- Professors
- Classrooms and physical space
- Time and personnel

- Benefits they obtain
- They can extend the amount of options for their students
- Future facilities to do research
- Better labs and teaching materials

Courses available

Course	Linkage to the ECHD
Bachelor in Biology - Minor in Laboratory Management - Minor in Chemistry teaching	**NONE**
Bachelor in Education Management and Administration - Minor in Education and Community development	**NONE**

Course	Linkage to the ECHD
Bachelor in Environmental Management and Community Development - Minor in Ecotourism	**LOW**
Bachelor in Mathematics Teaching	**LOW**
Bachelor in Chemistry - Minor in Laboratory Management - Minor in Biology teaching	**NONE**
Bachelor in Human Resource Management - Minor in Security and Hygiene in the work environment	**LOW**
Bachelor in Agriculture and Livestock teaching - Minor in in Rural extension	**NONE**
Electrotechnical Engineering(2012)	**HIGH**

Universidade Zambeze

Type of Actor: Higher Education Institution

Level of linkage to the EC: MEDIUM

Role(s)
Executive Council Member

Description

The UniZambeze is a public institution of higher education, it was created by Ministry decree in the 18 of December 2007 and it has it's headquarters in the city of Beira. It started activities on the 16 of March of 2009 working with a national scope.
The Faculty of Natural Resources and Environment Engineering are located on the city of Chimoio and it started it's activities in 2009 with only 1 course during the day, in 2010 it increased that to 2 courses one during the day and another one at nights.
With a total of more than 3300 students throughout the country, the University of Zambeze is becoming an important player in the educational sector.(UniZambeze 2009)

Interface with the EC

- Proposed contribution
- Professors
- Classrooms and physical space
- Time and personnel

- Benefits they obtain

- They can extend the amount of options for their students
- Future facilities to do research
- Better labs and teaching materials

Courses available

Course	Linkage to the ECHD
Environmental Engineering - Minor in Natural Resources and Environmental Management - Minor in Environmental Technologies	**MEDIUM to HIGH**
Rural Development Engineering - Minor in Sustainable Management of Rural Areas - Minor in Territorial Development	**MEDIUM**

ISPM

Type of Actor: Higher Education Institution

Level of linkage to the EC: LOW

Role(s)
Executive Council Member

Description

The Superior Politechnical Institute of Manica (ISPM) is a public institute of superior education created by the Mozambican Government. It has delegation in the administrative post of Matsinho, Gondola district, in Manica province, with an area that extends for almost 400 hectares. Juridically speaking ISPM is a collective person with public rights that has scientific, pedagogic, administrative and disciplinary autonomy.
The Superior Politechnical Institute of Manica has as mission to promote the economical and social development of the local communities of the region and of the country through the technical-professional education, economically oriented education and the promotion of new companies. Professional services are also provided to the communities.

Interface with the EC

- Proposed contribution

- Professors
- Classrooms and physical space
- Time and personnel

- Benefits they obtain

- They can extend the amount of options for their students
- Better labs and teaching materials

Courses available

Course	Linkage to the ECHD
Agricultural Engineering - Minor in Agro-Business	**NONE**
Ecotourism and Wildlife	**NONE**
Forestal Engineering	**NONE**
Zootechnical Engineering	**NONE**
Accounting and Auditing	**MEDIUM**

UCM

Type of Actor: Higher Education Institution

Level of linkage to the EC: HIGH

Role(s)
Superior Council - Hydropower Division

Description

The Universidade Católica de Moçambique was founded in Beira 1995 by Bishop's Conference in Mozambique and gradually extended into the seven provinces. Each faculty was developed under the auspices of a local bishop and therefore developed fairly idiosyncratically with their own procedures and supporting record systems. The first faculty to be established was in Beira in 1996 and the latest faculties to be included in the fold were in Pemba in 2002 and Chimoio in 2009.
UCM is a private, denominational university funded exclusively from student fees and donor funding.(Moore 2008)
It's research activities include the study today's society such as human dignity, promotion of equalitarian justice, personal and family quality of life, protection of the natural resources and politic piece and stability, and so on. (UCM)

Interface with the EC

- Proposed contribution

- Professors
- Classrooms and physical space

- Time and personnel

- Benefits they obtain
- They can extend the amount of options for their students
- Future facilities to do research
- Better labs and teaching materials

Courses available

Course	Linkage to the ECHD
Food Engineering	**LOW**
Civil Engineering	**HIGH**

Joaquim Marra

Type of Actor: Higher Education Institution

Level of linkage to the EC: MEDIUM

Role(s)
Executive Council Member

Description

Interface with the EC

- Proposed contribution
- Professors,
- Classes on how to build generators,
- Classrooms.

- Benefits they obtain
- Training in the field for professors and student
- Using the labs to perform their practices
- Maybe sell some generators

Courses available

Not available at the time of this research.

ESEG

Type of Actor: Higher Education Institution

Level of linkage to the EC: LOW

Role(s)
Executive Council Member

Description

Not available at the time of this reasearch

Interface with the EC

- Proposed contribution
None at the time, ESEG would like the center to be working before establishing a formal/legal relationship that needs to be approved in Maputo.

- Benefits they obtain
- Students would like to have practical exercises of things they lean
- It would allow students to see other options when they graduate
- Students could specialize in these fields

Courses available

Not available at the time of this research.

DIPREME

Type of Actor: Governmental Agency

Role(s)
External Advisory Board

Description

The provincial Directorate of Mineral Resources and Energy is at provincial level the representative of the Ministry of Energy and of the Ministry of Mines (which used to be together at national level). In Manica the Department of Energy (DE) which is the direct counterpart of AMES-M is composed of a director of department and four technical staff.

The main function of the DE is to monitor the implementation of the policies of the government in the province and supervision and inspection of all works related to energy around the province. (GIZ 2011)

Interface with the EC

- Proposed contribution
- They can provide part of the legal framework when it comes to energy and electricity

- Benefits they obtain
- The center would contribute in the long term to meet their objectives in rural electrification

DPOPH

Type of Actor: Governmental Agency

Role(s)
External Advisory Board

Description

The Provincial Directorate of Public Works and Housing is a governmental agency in charge of building and supervising all governmental related constructions and civil works. They also give trainings in the usage of local materials for construction purposes and of constructions technics in general to government agent and private sector under request.

Interface with the EC

- Proposed contribution
- Knowledge of construction with different materials
- Technical knowledge and technics in general constructions

- Benefits they obtain
- They want every regional employee (SDPI) to be trained in order to spread knowledge to the communities about HP

ARA-Centro

Type of Actor: Governmental Agency

Role(s)
External Advisory Board

Description

Created in the year 1991 by the decree 26/91 of 14 November, the Water Regional Administration are public institutions with a juridicial person and administrative, patrimonial and financial autonomy overlooked by the Ministry of Construction and Water through the Nacional Directory of Waters. It's geographical territory may be composed of one ore more hydrographic bodies.
Some of their competences are:

- Participate in the preparation, implementation and revision of the hydrological maps,
- Validation of water related works,
- Licensing and concession for public domain water usage,
- Technical Advice and knowledge transfer to other governmental agencies, public and private companies and the public in general,
- Solve conflicts due to water usage.

(CHISSANO 1991)

Interface with the EC

- Proposed contribution

- Advice on technical aspects
- Technical construction knowledge
- Water derivation and channeling
- Legal framework
- Measurements of water flow in different areas
- Instructors on the previously specified areas

- Benefits they obtain

- Their business is water, if the amount of HPP increase is better for them
- They would like that the center creates and maintains a database of the stations available (contact info, size, production, etc) to have a 1 point to accumulate all knowledge

FUNAE

Type of Actor: Governmental Agency

Role(s)
External Advisory Board

Description
The Fundo de Energia (FUNAE) was established in 1997 as a public institution to promote rural electrification and rural access to modern energy services, in a sustainable manner, and as a contributor to economic and social development in the country. Since its establishment FUNAE has implemented numerous projects using renewable energy technologies to electrify schools, clinics and communities.(GIZ 2011)

Interface with the EC

- Proposed contribution
- Share their experience in the field
- Give some lectures
- They advice that we make it very practical, but with local experiences

- Benefits they obtain
- Trained professionals
- Projects done by the graduates will help them reach their the electrification rate targets

Metalúrgica

Type of Actor: Private Company

Role(s)
External Advisory Board

Description

Metalúrgica is one of the biggest privately owned companies in Chimoio. It sells, among many other metal-made machines, turbines of up to 100 [kW]. Being the most common sizes 23 and 32 [kW] (pelton)
Currently they are working also in the electronics to control the turbines and in small Crossflow turbines to enter the pico system market .

Interface with the EC

- Proposed contribution
- They can provide hands-on training
- Some lessons can be given at the workshop
- They own machinery that could be used on the early stages of the project
- They offer their experience
- Instructors

- Benefits they obtain
- Trained people for Maintenance & Operation of the turbines they sell in the communities
- Trained people in the area of business and finance which will help the market to grow faster
- Training on request. After hiring a new employee they would like to have him/her going to the center to be trained for them in general aspects of theory/safety and usage of basic tools

AKSM

Type of Actor: NGO

Role(s)
External Advisory Board

Description

AKSM is a Mozambican NGO with the objective to improve the socio-economic situation and welfare situation of farmers and poor families in the Manica province. This is achieved by improving living conditions and food security, by a sustainable use of natural resources, which include renewable energy and environmental conservation. Also active in income generation and social activities, saving groups and HIV-AIDS information.

AKSM is a partner of AMES-M and Practical Action in the implementation of renewable energy projects in the Manica province.(GIZ 2011) They have been involved in several of the MPHP setups installed by GIZ and also have given trainings related to the HP field.

Interface with the EC

- Proposed contribution
Their contribution can be dived in two categories: give practical training, using the sites developed in the province. The other way of contributing is by giving some palestras in specific topics of MH

- Benefits they obtain
To create a better equipped team in KSM to respond more efficiently to the demand and challenges in the field of M

EDM

Type of Actor: Public Company

Role(s)
External Advisory Board

Description

The main electricity authority is Electricidade de Mozambique (EDM), established by the state in 1977, two years after independence. EDM, is a vertically-integrated, government-owned electric utility responsible for generation, transmission and distribution of electricity in the national grid. EDM buys most of its power supply (apr. 400 [MW]) from Hidroelectrica de Cahora Bassa (HCB), owner and operator of the Cahora Bassa Hydropower plant on the Zambezi (2,075 [MW).
Other large Hydropower plants in Mozambique under EDM's control include Mavuzi (52 [MW]); Chicamba (38.4 [MW]); and Corumana (16.6 [MW]).(EDM)

Interface with the EC

- Proposed contribution
- Experience workers to teach and share their experiences
- Instructors to teach subjects that are currently given in their training center

- Benefits they obtain
- Trained professionals to be hired by EDM

Banco Terra

Type of Actor: Financial Private Company

Role(s)
External Advisory Board

Description

Banco Terra is a commercial bank which objective is to provide financial and banking services in the rural areas of Mozambique, targeting especially business development. The development objective of Banco Terra is to

contribute to the Millennium Development Goal (MDG) of poverty eradication. (GIZ 2011)

The strategic objective is to provide the rural people with a range of financial and banking services in a sustainable fashion. The bank focuses especially the small entrepreneurs, the SMEs, rural enterprises and agriculture.(Terra)

Interface with the EC

- Proposed contribution
- They can provide training on how to prepare a business plan
- They can provide advice on the financial analysis of projects

- Benefits they obtain
- The center will increase awareness on communities about this technologies, and there for, the number of clients brining projects to the bank would also increase

GIZ AMES-M

Type of Actor: Development Organization

Role(s)
External Advisory Board

Description

AMES-M program has as core business the promotion of off-grid electricity supply systems based on renewable energies for rural communities through capacity building mechanisms. The program in Chimoio has three main objectives:

- Provide modern energy for lighting and small electric appliances to households through Micro/ Pico-Hydro, Grid Densification and Battery Charging systems.
- Provide modern energy for productive use by small and medium-sized enterprises, agro-processing cooperatives and craftsmen for employment creation and income generation
- Capacity building of local NGOs, Private Sector, Banks and Partner Institutions (MoE, FUNAE, and so on)

(Zana 2011)

Interface with the EC

- Proposed contribution
- Time and personnel
- Financial contribution to prepare labs
- Instructors

- Benefits in return

- The realization of such a training center would help GIZ AMES-M achieve their Capacity Building objectives,
- With more trained professionals on the field, the access to energy of disperse communities will also increase.

Instructors

Type of Actor: Instructors

Role(s)
Lecturer, Instructor

Description

The instructors are the teachers of the different Higher educational institutions, professionals, governmental agents, and so on, that share the knowledge they acquire throughout trainings, years of experience in the field, etc. with students of the different courses in the Excellence Center.

Interface with the EC

- Proposed contribution

- They will bring their knowledge and experience to the center

- Benefits they obtain

- Update in their fields
- They would be connected with others working in similar areas

Trainees

Type of Actor: Trainee

Role(s)
Trainee, Student

Description

The trainees of the Excellence Center are the students from the Higher education institutions, professionals, governmental agents, NGO workers, and public in general that want to improve their knowledge in any of the areas of

(small)hydropower covered by the Center.

Interface with the EC

- Proposed contribution
- Their experience in rural areas
- Money to keep the ECHD running

- Benefits they obtain
- Increased professional spectrum
- Gain a practical knowledge not given anywhere else
- Easier (self)employment

Community

Type of Actor: Community

Role(s)
External Advisory Board

Description

The community provides the people for every level of the center, instructors, trainees, public. Moreover, the center is located within a community, therefore, it cannot, in any way, violate written or established norms that rule the social and religious life of it's members and the the community in general.

Interface with the EC

- Proposed contribution
- The community provides the physical place and the people
- Local available knowledge and experience

- Benefits they obtain
- Higher employment rate for the community
- Increased general income
- Faster development

A3 - Training Centers abroad

The following is a list of the Training Centers we contacted during the development of this thesis project.

UNIDO Regional Centre for Small Hydropower

Location: Abuja, Nigeria

Website: http://unidorc.org/nigeria/default.htm

Contact Information
Mr. Dr. A. A. Esan
Telephone: +234 805 607 2928
Email: unidorcabuja@yahoo.com

Description

The objectives of Regional Centre for Small Hydropower (SHP) in Abuja, Nigeria, under the aegis of the Energy Commission of Nigeria, a Government body. The Centre will facilitate a variety of programs and projects related to renewable energy technologies in general and Small Hydropower in particular, within the country and the Western African Region. SHP has been identified as one of the most appropriate, environment friendly and economical renewable energy sources, which can provide convenient and uninterrupted energy to off-grid rural villages in Nigeria and the neighboring countries. It is envisaged that the Centre would play a critical role to promote and accelerate sustainable development through developing cost-effective technology, utilizing local equipment, materials and labour, providing training and awareness building programs on renewable energy systems and small Hydropower development schemes, organizing consultancy programs on comprehensive aspects of implementing RE systems and small hydro development. The establishment of the centre will further facilitate the implementation of necessary local infrastructure (encompassing academic, research, training and consultancy including linkage with manufacturers of parts and components to be used in electromechanical systems) to exploit the small hydro potential to the fullest. (UNIDO)

Courses given

- Seminar in Implementing Small and Micro Hydro Projects in the ECOWAS Region

International Network on Small Hydropower

Location: Hangzhou, People's Republic of China

Website: http://www.inshp.org

Contact Information
Ms. Lara Jin Qiu-ting Esser
Cellphone:+86 18858298436
Email: lara@icshp.org

Description

Co-sponsored by United Nations Organizations (UNDP and UNIDO) and the Chinese government in 1994, after the multilateral negotiations among member organizations, the International Network on Small Hydropower was created. The headquarters building for IN-SHP was constructed within a record time of 10 months and inaugurated for use in 1998, with funding from the Chinese government. The approval of State Council of China, the hosting country of IN-SHP in 1999, made IN-SHP as the first international institution to have ever been established in China. The following year, the legal status of the International Center on Small Hydropower was approved by the Central Institutional Commission and, with an official Trust Fund agreement between the government of China and UNIDO, a new part of IN-SHP, the International Center on Small Hydropower (IC-SHP) came under the auspices of UNIDO.(UNIDO-UNDP)

Courses given

Since 1994, IN-SHP has provided training courses for about 600 engineers from 60 countries, including short term courses, on-the-job training & training courses in IN-SHP member countries co-organized with local government and/or other international organizations, such as UNDP, UNIDO, E-7, G77, GTZ, EREC, OLADE etc. The training workshop cover site selection, design, operation & maintenance, equipment manufacturing, development policy & finance etc. Some international training workshops are listed as the followings:

- Seminar on Small Hydropower and Sustainable Development of Rural Communities for Officials. Hangzhou, China (April-May, 2008).
- SHP Training Workshop on Site Selection & Design. Hangzhou, China (November-December, 2007).
- The Second CIDA/MOFCOM Small Hydro Technology Transfer & SHP CDM Training Workshop. Hangzhou, China (October, 2006).
- Small Hydropower Development in SADC Countries. Harare, Zimbabwe (November, 2005).
- Small Hydropower Development. Kathmandu, Nepal (August, 2005).
- SHP Automation Technologies. Hangzhou, China (June, 2005).

- Micro Hydro Development and Its Productive Use for Nagaland of India. Hangzhou, China (June, 2005)
- EU-China Renewable Energy Workshop for Synergy Program. Hangzhou, China (May, 2005)
- SHP Design Workshop in Papua New Guinea (October 2004)
- SHP Operation of Four Pilot SHP Projects in Kerala. Calicut, India (August-December, 2004)
- SHP Training Workshop in Uliastai, Mongolia (June 2004).
- Nigerian National Workshop on "Capacity Building on Small Hydropower for the Provision of Rural Energy" (May 2004).
- SHP for Asia and African Countries. Trivandrum, India (November, 2003)
- Micro Hydro for Philippine. Hangzhou, China (June, 2003)
- SHP Developers in Indonesia. Jakarta, Indonesia (January, 2003)
- SHP On-the-Job Training Course. Hangzhou, China (2003) 3 experts from Nigeria, Fiji and Bangladesh.
- Micro Hydropower Workshop for the Philippines. Hangzhou, China (September 2001) 12 participants from the Philippines.
- IN-SHP/EMC Training Workshop on SHP Development for South Asia. Kerala State, India (June 2001)
- SHP for Jamaica. Kingston, Jamaica (April, 2001)
- Three China SHP Study Tours (April, May, October 2000) 18 participants from 5 countries in total.

Kafue Gorge Regional Training Centre

Location: Namalundu , Zambia

Website: http://www.kgrtc.org.zm/

Contact Information
Eng. Kaela K. Siame
Telephone: +260 211 371007/8
Email: info@kgrtc.org.zm

Description

The Kafue Gorge Regional Training Centre (KGRTC) is a long established institution for hydro-power training which was rehabilitated and transformed to provide quality training to regional power utilities. The centre has earned an international reputation in provision of excellent accommodation and conference facilities and is ISO 9001 certified for quality training provision.
The centre has made substantial investment in training aids and simulators. The simulators imitate computerized and conventional hydropower stations. The centre has a number of fully equipped

training laboratories, well stocked library and over 2,700 course participants from all over the world have trained at the Centre.

The Project of transforming the Centre into a SADC Regional Training Centre was jointly sponsored by cooperating partners namely:

- The Norwegian Agency for Development Cooperation (NORAD)
- The Swedish International Development Cooperation Agency (Sida)
- Zambia Electricity Supply Corporation (Zesco)

In the year 2000, the centre was first ISO 9001 certified and since then KGRTC has successively retained the certification.

Courses given

There are several courses given by this Regional Center, this is a list of the upcoming ones:

Power Systems Operations and Maintenance courses
1 Plant Operations
2 Power Plant Operations and Control
3 Operations and Maintenance
4 Distribution Systems Operations
5 MV Switchgear Operations and Maintenance
6 Control Room Operations
7 Shift Charge Operations
8 Power System Operations
9 Substation Operations and Maintenance
10 Turbine Dynamics and Operations
11 Switchgear Operations and Maintenance
12 Thermal Power Plant Operations and Maintenance
13 High Voltage Regulations

Engineering Maintenance courses
14 Maintenance Routines
15 Transmission Lines Maintenance
16 Generation Maintenance Management System
17 DC Power Systems Maintenance
18 Maintenance Management Systems
19 Maintenance and Troubleshooting of Distribution Systems
20 Distribution Lines Maintenance
21 Transformer and Switchgear Maintenance
22 Overhead Lines Inspection Techniques
23 Generator Inspection, Testing and Maintenance

Engineering Applications and Management courses
24 SCADA Systems Management
25 Applied Industrial Hydraulics
26 Fluid Flow and Centrifugal Pumps
27 Power Systems Planning

28 Cable Jointing and Termination
29 Machinery Vibration Monitoring and Analysis
30 Power Distribution Management
31 Geographical Information Systems
32 Microprocessor Logic Controls
33 Energy Management
34 Hydraulics and Turbine Regulations
35 Power System Protection
36 Small Hydropower Development
37 Generator Performance Dynamics
38 Advanced SCADA Systems Management

Safety, Health, Environment and Quality Assurance courses
39 Dam Safety Management
40 Environmental Assessment and Information Management
41 Industrial Occupational Health and Safety Management
42 Safe Management of PCBs
43 Divers and Rescue
44 Rain Water Harvesting
45 Water Production and Management
46 Quality Management Systems QMS On Demand

Corporate Governance, Management and Leadership Development courses
47 Training of Trainers
48 Project Management
49 Strategic Management
50 Customer Care
51 Supervisory Leadership
52 Financial Management in Utilities
53 Procurement and Materials Management in Utilities

Arba Minch Hydropower Center of Excellence

ARBA MINCH UNIVERSITY
Arba Minch Institute of Technology
Hydropower center of excellence

Location: Arba Minch, Ethiopia

Website: Not Available

Contact Information
Mr. Yonas Gebretsadik
Telephone: +251-46-8810070 / Fax: +251-46-8810279
Email: yonnasgk@gmail.com

Description

Arba Minch Institute of technology (Arba Minch University) is a place for specialization in water resource engineering and has been teaching and conducting researches in different water sectors for the last previous two decades.
This specific establishment of center of excellence perfectly complies with the mission of Arba Minch University which is to be one of the leading Higher Educational Institutions in the country and a centre of excellence in the area of water resources in Eastern Africa.

- To educate people in mini hydropower system through customized short courses terms, demonstration Projects and awareness programs throughout the country
- To provide advisory services in mini hydropower systems maintenance, design, installation and efficient use of energy
- To support private MHP developers technically
- To set up a demonstration and testing laboratory for Mini hydropower systems in Arba Minch and with a number of demonstration kits to be displayed in rural communities
- To promote and create network with different initiatives NGOs and governmental organizations
- To make the CoE as resource center by organizing database and metadata
- To offer specialist course in renewable energy systems at postgraduate levels

(Arba-Minch-University 2011)

Courses given:

- International Training on Micro-Hydropower development

A4 - Suggested Roles

Suggested roles for the Individual Actors

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Approval

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Roles

According to our research results and based on the current and future objectives of the individual stakeholders in the ECHD project, GIZ suggests that the roles are occupied as described bellow during the first 3 years of the Center's establishment:

Executive Council Members

- Universidade Pedagógica,
- Universidade Católica de Moçambique,
- Instituto Superior Politecnico de Manica and
- Universidade Zambeze.

with the future possibility of including

- Escola Superior de Economia e Gestão and
- Escola Superior Joaquim Marra.

Superior Executive Council of the Hydropower Division

- Universidade Pedagógica,
- Universidade Católica de Moçambique and
- Universidade Zambeze

President of the Hydropower Division

- Universidade Pedagógica.

A5 - Memorandum of Understanding

Memorandum of Understanding

between

Universidade Pedagógica,

Universidade Católica de Moçambique,

Instituto Superior Politecnico de Manica and

Universidade Zambeze

for the creation of

Chimoio's Excellence Center Hydropower Division

Preamble

The Universidade Pedagógica - Manica Delegation, with offices in Rua da Zâmbia, nº 462, Chimoio City, from now on designated as UP, represented on this meeting by its Delegation Director, Mestre António Cristos Pinto Madeira.
and
The Universidade Católica de Moçambique, with offices in Estrada Nacional nº 6 Bº Centro Hípico, Chimoio City, from now on designated UCM, represented on this meeting by its Director, Joao Luis Ferrao.
and
The Instituto Superior Politecnico de Manica, with offices in Estrada Nacional nº6 Desvío das Antenas Km 4,5 Matsinho, Chimoio City, from now on designated ISPM, represented on this meeting by its Director, Dr. Rafael Massinga.
and
The Universidade Zambeze, with offices in Bº Namatsane, Chimoio City, from now on designated as Uni-Zambeze, represented on this meeting by its Director, Prof. Dra. Alda Pereira Massinga.

Considering that the cooperation in between them will play an important role in the complete achievements of their current and future objectives;

Considering that all are Higher Education Institutions that exercise learning activities, research and strive to the development of the Mozambican human capital.

And accepting that the outcome that can be achieved by working together, will always be greater that acting as single units,

have come to the following agreement.

Article 1

The present Memorandum of Understanding has as objective to establish the main directives for the creation of Chimoio's Excellence Center and its Hydropower Division.
From now on, al the signing parties will be collectively known as the Executive Council of the Excellence Center.
The structure and roles are further explained in the Terms of Reference(ToR) written for this purpose.

Article 2 (responsibility)

It is the responsibility of all the signing institutions to:

a. To provide facilities, as long as it is possible for the Institution, to be used for giving training, laboratories, seminars, and so on. Under the conditions explained in the ToR.

b. To provide human capital in the areas needed by the Excellence Center to function as Instructors of the Center under the terms explained in the ToR.

c. To collaborate with their partners by sharing available knowledge and material related to the objectives of the Excellence Center.

d. To promote the image and the importance of the Excellence Center for the future of the Institutions and the community.

e. To restrain themselves of using the name of the center, pictures or similar materials to promote activities that were not approved by the Executive Council.

f. To cooperate with the rest of the members by assigning the required time and personnel for meetings and activities related to the Center.

Article 3 (management)

The present Memorandum of Understandings management will be done by the Directors of the respective Institutions according to their role in the Excellence Center as agreed by the members and in concordance with the Terms of Reference. Some of their tasks will be:

1. Coordinate on the actions of joint coordination needed to achieve the objectives proposed in this Memorandum of Understanding and the Terms of Reference.

2. Analyze the results against the expected outcomes of this Memorandum of Understanding and the Terms of Reference and proposing measurements to improve future results.

3. Agree in a Superior Council for the management of the Hydropower Division as per the ToR

Article 4 (Evaluation)

1. On a biannual basis, the Executive Council will meet to review the progress and the objectives achieved based on the Terms of Reference Implementation Plan, and to review the President’s report. In case of need, extraordinary meetings will take place to solve urgent matters.

2. By the end of the President's term, the Executive Council will also meet to evaluate it's performance.

3. Yearly, the President will produce a report that will be publicly available showing the objectives achieved by the Excellence Center.

Article 5 (Validity)

The present Memorandum of Understanding will be valid since its date of signing and for a period of 3 years that will be renewed by the members equal successive periods if in the period of 60 days before the finish date non of the parties express their will to finish it.

Article 6 (Cancellation)

The present Memorandum of Understanding can be canceled by any of the parties in the case of not compliance with the articles or conditions through a written notification to the rest of the parties, with 60 days prior notice and confirmed reception.

Article 7 (Non corruption)

The parties commit to avoid any situations that directly or indirectly can be considered acts of corruption, as well as to ask, offer, or receive, for their own or other, offers with the purpose of obtain favorable conditions over services or products. (Law nº 6/2004, de 17 of June).

Article 8 (Conflict management)

Eventual conflicts that may arise regarding the interpretation of how to implement this Memorandum of Understanding and the Terms of Reference for Chimoio's Excellence Center will be done in a friendly manner by the Executive Council members keeping in mind that the objective is to achieve the best outcome for the community and all the participants.

Article 9 (Omissions)

Any doubts or omissions related to the present Memorandum of Understanding or the Terms of Reference interpretation will be discussed and solved by the Executive Council by the applicable legislation at the moment of celebration.

Article 10 (Commencement date)

The present Memorandum of Understanding is valid since its date of signing, and it's celebrated with 4 (four) equal copies, to be signed and initialed in every page. Each party will keep 1 (one) copy in their possession.

Chimoio, at _____ days of March of 2012

From UP

Mestre António C.P. Madeira
(Director)

From ISPM

Dr. Rafael Massinga
(Director)

From UCM

Joao Luis Ferrao
(Director)

From Uni-Zambeze

Prof. Dra. Alda Pereira Massinga.
(Director)